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Creel, Escapement, and Stock Statistics for Coho Salmon on the Little Susitna River, Alaska, during 1991

by

Larry D. Bartlett

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ABSTRACT

Coho salmon *Oncorhynchus kisutch* returns to the Little Susitna River were assessed with a creel survey to estimate sport harvest by boat anglers and a weir to estimate spawning escapement. Creel surveys were conducted at the Burma Road boat landing from 16 July through 2 September 1991 and at Miller's Landing and Reach from 9 August through 2 September to estimate the effort for and the catch and harvest of coho salmon by boat anglers in the sport fishery. An estimated 14,079 coho salmon were harvested and an additional 4,165 coho salmon were caught and released during 36,411 boat angler-hours of effort. The majority of the effort (33,769 hours) and harvest (13,514) occurred at the Burma Road survey site. Most of the harvested coho salmon were age 1.1. The contribution of hatchery-produced coho salmon to the sport harvest and escapement past the weir was estimated to be 46.8% and 21.4%, respectively. Returning hatchery coho salmon originated from 1990 smolt releases in Nancy Lake and in the mainstem Little Susitna River at Houston, Alaska and from a 1988 Little Susitna River drainage fry release.

A total of 52,332 coho salmon were estimated in the Little Susitna River during 1991. The actual inriver return, however, was somewhat greater than 52,332 because of the unsurveyed harvest by shore anglers and boat anglers who accessed the sport fishery through the Port of Anchorage. An unknown number of coho salmon were also harvested in the mixed-stock commercial fisheries of upper Cook Inlet. A total of 14,079 coho salmon were harvested in the boat angler sport fishery: 13,091 fish below the weir and 992 fish above the weir. Spawning escapement was estimated at 38,249 fish. Coho salmon are not known to spawn downstream of the weir. Inriver exploitation by the boat angler sport fishery was estimated at 27%.

KEY WORDS: coho salmon, *Oncorhynchus kisutch*, creel survey, escapement, age, sex, length, sport effort, sport harvest, sport catch, hatchery contribution, Little Susitna River, smolt, stocking, weir.

INTRODUCTION

The Little Susitna River (Figure 1) has had the highest sport fishery effort in the Matanuska-Susitna Valley since 1981 and currently supports the second largest freshwater fishery for coho salmon *Oncorhynchus kisutch* in Alaska (Mills 1979-1991). Road access to the lower reaches of the Little Susitna River improved with agricultural development in the area during the early 1980s. The harvest of, and corresponding fishing effort for, coho salmon in the lower 60 km of the Little Susitna River also increased in step with improvements in access. In response to the increases in harvest, the Little Susitna River has been stocked annually with coho salmon since 1982 (ADF&G 1981, Chlupach 1989).

The Alaska Department of Fish and Game (ADF&G), Division of Sport Fish, began an annual creel survey of the sport fishery for coho salmon in the Little Susitna River in 1981. An annual life-history study of coho salmon in the Little Susitna River was begun in 1982. As part of this study, a weir was constructed in the Little Susitna River to estimate the escapements of coho salmon. This weir was initially operated in 1986 and has been operated annually since 1988. A coho salmon management plan was adopted in 1990 for implementation in 1991. This management plan defines an escapement goal of 7,500 nonhatchery coho salmon for the Little Susitna River upstream of the Parks Highway bridge at river kilometer (rkm) 112 (ADF&G 1991). The creel surveys and life history studies are summarized in a series of annual "Federal Aid in Sport Fish Restoration" reports published by ADF&G.

The objectives of the 1991 Little Susitna River creel and escapement studies of coho salmon stocks were to:

1. estimate the sport boat angling effort for and the catch (number kept plus number released) and harvest (number kept) of coho salmon above and below the weir at rkm 52 of the Little Susitna River during the period 16 July through 2 September 1991, by 7-day strata, such that the total seasonal effort estimate was within ± 15% of the true value 95% of the time, and the total catch and harvest estimates were within ± 25% of the true value 95% of the time;

2. estimate the coho salmon catch rate (fish per angler-hour) and angler success (harvest per angler-day) of the total, guided and unguided components of the boat angler sport fishery[1];

3. estimate the age and sex compositions of the coho salmon harvested in the sport boat fishery and in the escapement past rkm 52, such that the estimated proportions by age class were within ± 10 percentage points of the true proportions 90% of the time;

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[1] There were no objective criteria for estimating catch per unit effort (CPUE) or angler success. The precision for CPUE and angler success realized from obtaining the noted catch, harvest, and effort total estimates sufficed for this objective.

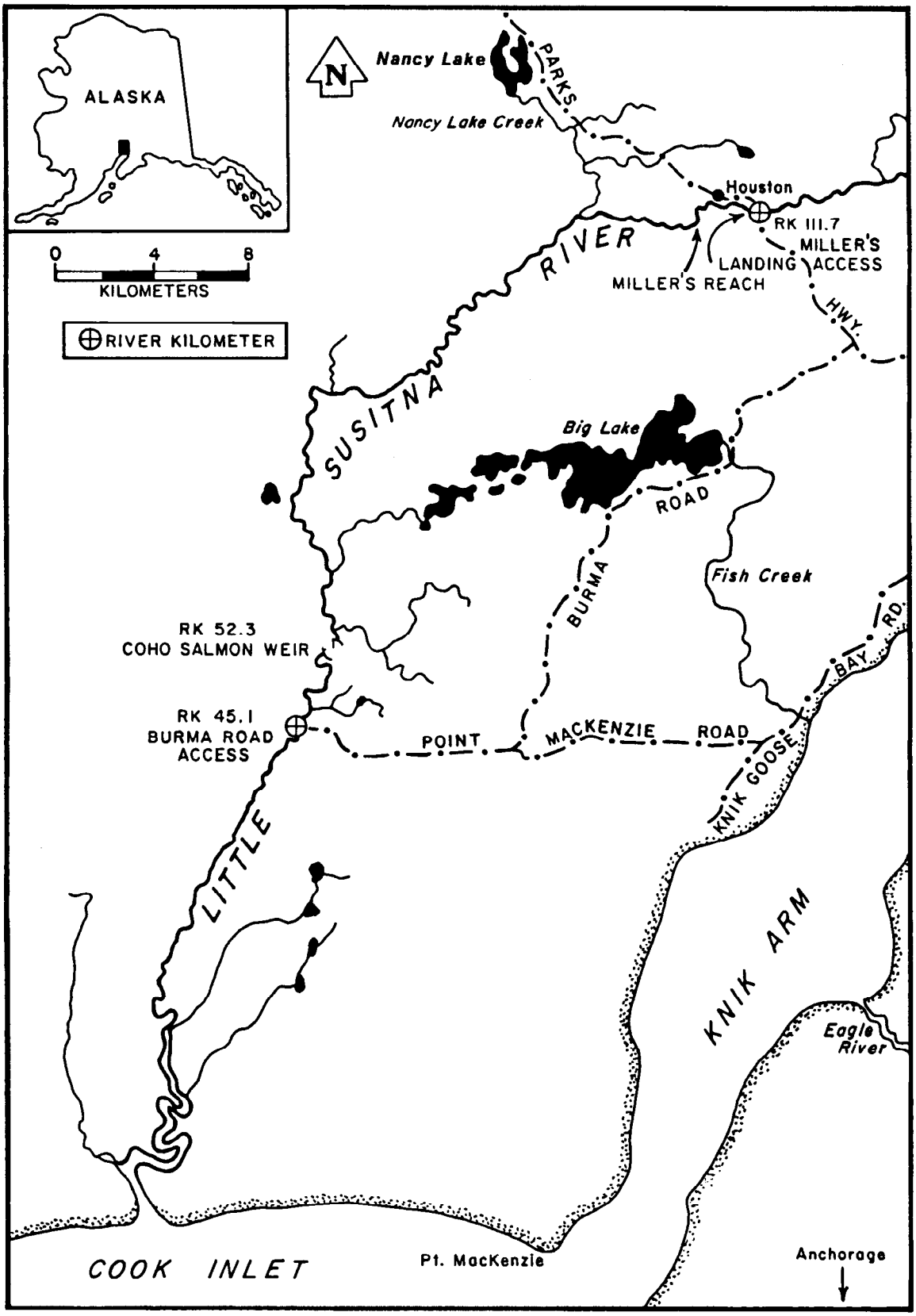

Figure 1. Little Susitna River study area.

4. estimate the contribution of stocked coho salmon to the sport boat harvest and to the escapement past rkm 52 by 7-day strata, such that the total seasonal estimated contribution was within ± 15% of the true contribution 80% of the time;

5. census the escapement of coho salmon in Little Susitna River past rkm 52; and

6. index, by aerial survey, the peak spawning escapement of coho salmon in selected index areas of the Little Susitna River.

The results of the 1991 coho salmon effort, harvest, and catch creel survey; escapement through the weir (rkm 52); the sex, age, and length composition of the harvest and escapement; the aerial escapement index; the hatchery contribution to the harvest and escapement; stocking, and egg collection programs are summarized in this report. This report includes a discussion of the results of the program relative to attainment of the program objectives, inseason management, the 1990 coho salmon management plan, and the stocking and egg collection programs. Recommendations for future program planning are also developed.

METHODS

Creel Survey Design

Approximately 113 km of the Little Susitna River were open by regulation to salmon fishing during 1991 (ADF&G 1991)[2]. There were three major access points to the fishery: (1) the Burma Road boat launch at rkm 45.1, (2) the boat launch at Miller's Landing in the city of Houston at rkm 111.7, and (3) Miller's Reach at rkm 107.0. The Port of Anchorage (in the Municipality of Anchorage) is a fourth, but not a major, access to the sport fishery. Anglers who exit the sport fishery through the Port of Anchorage are known to fish the tidal portion of the river from boats that are capable of crossing the Knik Arm of Cook Inlet.

Burma Road:

Previous research (Bartlett and Vincent-Lang 1989, Bartlett and Sonnichsen 1990, Bartlett and Bingham 1991) has shown that 80% to 90% of the catch and harvest for anglers exiting at Burma Road has been taken by boat anglers who represented 70% to 80% of the effort during fisheries for coho salmon. Because not all the access sites were surveyed, and the large majority of the effort was by boat anglers, a stratified-random, three-stage, direct-expansion creel survey was conducted to estimate angler effort in hours, and the coho salmon catch and harvest of only boat anglers. Boat anglers were defined as anglers who accessed their fishing site via a boat. This includes anglers who used a boat to travel to a fishing site but fished from shore once they reached the site. The catch rate (per angler hour) and angler success

[2] A 458 meter reach of river was closed immediately downstream of the weir, and a 92 meter reach immediately upstream of the weir (rkm 52) was closed by emergency order.

(harvest per angler day) were also estimated from data gathered during the boat angler creel survey.

The survey at Burma Road began on Tuesday, 16 July and continued through Monday, 2 September. The survey was primarily stratified into 7-day strata[3] which were further divided into four "weekday" days (Tuesday, Wednesday, Thursday, and Monday) and three "weekend" days (Friday, Saturday, and Sunday) for a total of 14 weekend and weekday strata. The division of days in this manner was necessary to agree with the coho management plan which required a change in the coho salmon bag limit from one to three coho salmon beginning on 6 August, and to obtain estimates on a timely basis for inseason management decisions. Stratification by type of day (weekday versus weekend) was primarily directed at reducing bias within (and among) 7-day periods, and secondarily at increasing the precision of our estimates, since the variance components associated with the survey were different between these two day types. The strata definitions, along with pertinent sampling information for the Burma Road boat creel survey, are summarized in Appendix A1.

As noted, the survey was of a three-stage design, with the first stage being days; the second stage units, periods within days; and the third stage units, anglers within periods sampled. The length of the fishing day and the number of the daily periods changed with the decreasing length of daylight hours as the season progressed. The daily periods are presented in Appendix A2.

Two days were randomly sampled without replacement (WOR) from the 4 weekdays of each 7-day stratum throughout the season to sample. All weekend days were sampled (i.e., censused). Two sample periods during each day were selected (WOR) and sampled. All anglers were interviewed as they exited the Burma Road access location, and as such, the third-stage sampling units were censused (and the design collapsed to a two-stage survey).

Miller's Landing and Miller's Reach:

A small sport fishery (approximately 1,000 coho salmon harvested) exited the river through two boat landings near Houston. The landings are geographically separated by approximately 2.5 river kilometers. Anglers who exited the fishery through these landings fished the same locations near and at the confluence of Nancy Lake Creek with the Little Susitna River at rkm 103. A direct expansion survey was also conducted at the Miller's Landing and Miller's Reach landings to estimate angler effort in hours, and the catch and harvest of coho salmon by boat anglers exiting from these two locations. The survey started on Friday, 9 August and ended on Monday, 2 September. It was stratified by location (Miller's Landing or Miller's Reach); 7-day periods; and type of day: "weekday" days (Monday through Thursday), and "weekend" days (Friday through Sunday).

The Miller's Landing and Miller's Reach survey was also of a stratified, three-stage sample design with days to sample within each stratum being the first stage units, periods within each day the second stage units, and anglers

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[3] Strata numbers 8 and 10 were adjusted in length to agree with an emergency order changing the bag limit from three to five coho salmon on 14 August 1991.

within periods the third stage units. The length of the fishing day also decreased with decreasing daylight hours as the season progressed. The periods and length of days were the same as for corresponding days at Burma Road.

Coho salmon do not usually arrive in the vicinity of the Nancy Lake Creek confluence in numbers sufficient to start a survey until after the first week of August. The 1991 schedule was, therefore, prepared with the assumption that the survey could start as early as 9 August. The strata for the Miller's Landing and Miller's Reach creel survey, along with pertinent sampling information, were as listed in Appendix A3.

Days to sample within each of the 16 strata were first selected at random (WOR) for Miller's Landing because more effort, catch, and harvest had been estimated for this location (Bartlett and Vincent-Lang 1989, Bartlett and Sonnichsen 1990, Bartlett and Bingham 1991). After selecting days to sample for the Miller's Landing site, the remaining days were sampled at random for surveying the Miller's Reach site. Exceptions to this procedure were that during strata with less than 4 days available for sampling (i.e., weekend strata and strata 16 and 22; Appendix A3), sampling was of necessity at both locations. As such, a constrained random sampling occurred for the Miller's Reach strata. Since less catch, effort, and harvest were expected to exit the fishery at this site, this procedure minimized any bias related to the constrained sampling of days.

Within all sampled days, regardless of strata, two 4-hour periods within each day were chosen at random (WOR) for sampling. As such, periods represent the second stage units in our three-stage design. Anglers exiting the fishery during a sampled period (within a sampled day at a particular site) represent our third stage units. All exiting anglers were interviewed and the design collapsed to a two-stage survey.

Creel Survey Data Collection

A standard Alaska Department of Fish and Game, short interview creel survey form was used to record the interview information from completed-trip boat anglers departing the Little Susitna River coho salmon sport fishery through Burma Road, Miller's Landing, and Miller's Reach locations. The following questions were asked of each interviewed boat angler:

1. the total time the angler fished;
2. the number and species of fish harvested (kept);
3. the number and species of fish released;
4. whether the angler had completed his/her trip (completed-trip interview) or not (incompleted-trip interview);
5. whether or not the angler was guided;
6. whether the angler fished upstream or downstream of the weir; and
7. the number of days (calendar) the angler spent fishing.

Creel survey personnel maintained daily summaries of the number of anglers interviewed, the total daily effort in hours, and the number of coho salmon harvested and caught.

Creel Survey Data Analysis

Angler interview and count mark-sense forms were visually scanned for errors and corrected as necessary. Corrected forms were sent to Research and Technical Services (RTS) for optical scanning. Resultant data files and summary printouts were checked for errors and corrected as necessary. Corrected data files were sent back to RTS for archiving.

Data sets were processed by Division of Sport Fish's creel survey analysis computer program, and analyzed according to the procedures outlined below.

Angler Effort, Catch, and Harvest:

The procedures used to estimate effort, catch, and harvest for all locations in the 1991 survey (i.e., Burma Road, Miller's Landing, and Miller's Reach) were the same as those used in the 1990 boat angler survey. The procedures are outlined in equations 1 through 10 in Bartlett and Bingham (1991), and represent a three-stage direct expansion estimation approach. This approach involved the direct expansion of sampled interview data by expansion factors dependent upon the number of anglers counted (third-stage units), sample periods (second-stage units), and days (first-stage units). Since all anglers counted were interviewed, the design collapsed to a two-stage design, however estimates were still obtained in a three-stage manner, and were equivalent.

Catch Per Unit of Effort:

Catch per unit effort (CPUE) of anglers fishing for coho salmon in the Little Susitna recreational fishery surveyed during 1991 was estimated by the procedures noted below. The anglers were treated as individual units in a test fishery operating under the traditional linear model:

$$[c/e]_i = q\,N + \epsilon_i$$

where: c/e is the catch per unit of effort during the *ith* angler-trip, N is abundance (of the fish), q is the catchability coefficient, and ϵ is random error with mean = 0 and variance = σ^2.

Hence the estimates of CPUE were obtained from unweighted means for each section of the fishery during each time period stratum[4] as detailed in Appendix A4. The estimates obtained by these procedures were indicative of the abundance of coho salmon as they passed through the fishery.

Distribution of Angler Catches and Harvests:

The distribution of angler catches and harvests was used as a measure of angler success and was estimated as described in the following text. The "distribution of catches and harvests" was defined as the fraction p_k of angler-trips in which "k" or more fish were caught and "k" was expressed as

[4] Assuming that abundance and hence catch rates varied among areas in the fishery and among seasonal periods, but did not change appreciably among sampling stages.

$k = 1$ to k_{max}. Additionally, we defined p_k to be the proportion of angler-trips that resulted in the catch or harvest of zero coho salmon for $k = 0$. If $k_{max} = 5$, then one set of data was analyzed 6 times to obtain all possible fractions p_k in a set. There were two sets of p_k's, one set for both catch and harvest. Besides the k_{max} iterations, there was stratification. For each iteration from 0 to k_{max}, there were calculations for each stratum in the fishery.

An unknown portion of the anglers exiting the boat angler sport fishery at the surveyed locations typically fish more than one angler day. However, because the bag and possession limits are the same for this fishery, we ignored the number of angler-days per trip in the analyses of angler success.

As an example, we began with the fraction of angler-trips in which one or more coho salmon were caught. The first step was to code the data prior to calculation. The coding was necessary because not all sampling periods (days) were the same "size": more anglers fished during some periods than others. Ignoring these differences in size would have promoted bias in estimates of angler success when statistics were averaged across sampling periods within a stratum. The coding adjusted for this possible discrepancy (Sukhatme et al. 1984). After coding, standard three-stage estimation procedures (Cochran 1977) were used to estimate the various proportions, their variances, and standard errors (Appendix A5).

Assumptions:

The assumptions necessary for unbiased point and variance estimates of angler effort, catch, harvest, CPUE as an index of abundance, catch and harvest distribution, and proportion of harvest by bag size, obtained by the procedures outlined above, included the following:

1. interviewed boat anglers were representative of the total boat angler population;

2. interviewed boat anglers accurately reported their hours of fishing effort and the number of coho salmon caught and the number of coho salmon released;

3. no significant fishing effort occurred during the hours not included in the fishing day; and

4. no significant fishing effort occurred in areas not covered by the survey;

5. all boat anglers participating in the fishery exited the fishery through a surveyed access site; and

6. catch and harvest rate and duration of fishing trip were independent (DiCostanzo 1956).

We also assumed that the catchability coefficient (q) did not change in a manner that would negate the use of CPUE as an index of abundance. Finally, for unbiased estimates of CPUE as an index of abundance, we assumed that "good" (or for that matter "poor") anglers were not selectively fishing during

certain periods of the fishery. However, high catch rates may be more reflective of good anglers (higher catchability coefficients) rather than higher abundance (and visa versa for poor anglers).

With regard to assumption 1, boat anglers interviewed at the Burma Road and Miller's survey sites are representative of all boat anglers exiting the fishery through the respective sites because, with the exception of those fishing the tidal reach of the river and exiting through Ship Creek, all boat anglers must exit through these access sites. Boat anglers who exit through Ship Creek fish in the same river areas as the boat anglers who exit through Burma Road. With regard to assumption 2, not all boat anglers were able to remember the hours of fishing effort and tended to report a number of hours somewhere between the length of the trip and the actual number of hours spent fishing on the trip. Assumption 3, above, is in general valid because boats are generally not navigated on the river during hours of darkness. Assumption 4 is valid for the same reason as in assumption 1. Regarding assumption 5, a portion of boat anglers fishing within the tidal reach of the Little Susitna River exited the fishery through the Port of Anchorage, as such our estimates only reflect the catch, effort, and harvest of anglers exiting at the surveyed locations. Regarding assumption 6, the catch and harvest rates relative to the duration of the fishing trip are independent because the harvest rate is controlled by a daily bag and possession limit while the catch rate is controlled by the length of the trip.

Weir Census Design and Data Collection

A weir program was used to census the escapement of coho salmon past rkm 52. A floating weir was placed across the Little Susitna River at rkm 52 from 25 July through 15 September (Figure 1). The weir was a resistance-board design modified to pass boats. A live trap with a V-shaped entrance was placed on the upstream side of the weir. Spacing between the weir and live-trap pickets was 38 millimeters. This spacing allowed for the complete census of all but the smallest 0-ocean (jack) coho salmon past rkm 52. Information collected daily at the weir is listed in Appendix B1.

Escapement Survey Design and Data Collection

Spawning coho salmon were counted from a Hughes 500D helicopter on 4 October within established index areas (rkm 99 to rkm 168) during the peak spawning period under clear weather and water conditions. Spawning activity was frequently monitored to determine the peak period. Individual fish were counted from a height of 25 to 40 meters above the stream bed with polarized sunglasses and recorded on hand tallies. Information recorded by the observing biologist during the aerial survey is listed in Appendix B2.

Weir and Escapement Survey Data Analysis

Daily summaries of information collected at the weir were forwarded by telephone to the area office each weekday. Daily escapement data were entered into a computer spreadsheet.

The raw survey count of coho salmon was considered the escapement index; no expansion was made to account for streamlife, missed fish, missed area, or visibility. Escapement indices are considered to be minimum escapement

estimates. By following consistent survey procedures among years and conducting these surveys at peak spawning periods, escapement indices can be treated as a relative measure of the abundance of coho salmon on the spawning grounds. These records were archived in the historical stream files in the Palmer, Alaska area office.

Biological Sampling Design and Data Collection

Age and sex compositions of coho salmon were estimated for the harvest by sampling during the creel survey, and for the escapement by sampling at the weir.

Hatchery coho salmon from smolt releases are almost exclusively age 1.1, while nonhatchery coho salmon and those from hatchery fry releases may be ages 1.1, 2.1, or 3.1. Age compositions may change over time as the contribution of hatchery and nonhatchery fish to the harvest or escapement change or the age composition of the nonhatchery stock varies. We attempted to sample a minimum of 65 fish per 7-day stratum (455 fish total) both in the harvest and at the weir. When sampling fish at the weir, the sample was obtained by allowing the live trap to fill with the approximate number of coho salmon needed for the sample (10-15 fish per day). The entire contents of the trap were then sampled to eliminate selection or behavior biases inherent in subsampling fish from the trap by dipnetting.

Three scales for aging were collected from the left side of each sampled fish, two rows above the lateral line and on the diagonal row downward from the posterior insertion of the dorsal fin (Clutter and Whitesel 1956). Scales were mounted on gum cards and impressed in cellulose acetate as described in Clutter and Whitesel (1956). Age determinations were made using a microfiche reader and recorded by the European method.

Sex composition of coho salmon has been shown to change over time inseason and between years. The sex of those fish randomly selected for age composition was recorded. Sex ratios were estimated on a 7-day stratum basis to coincide with the creel survey strata. In addition to this random sample of sex composition, the sex of all fish examined in the harvest for a missing adipose fin was recorded to increase the sex composition database. The sex ratios were estimated by 7-day stratum to coincide with the creel survey strata. Coho salmon were sexed based on external characteristics.

Biological Sampling Data Analysis

Estimates of age composition (proportion), by sex, for the subsampled coho salmon were calculated for each stratum for the creel survey and at the weir. Estimates of proportion of fish harvested by sex and age class across all strata were obtained by a weighted means procedure. Complete details of the estimation procedure are presented in Appendix C.

Hatchery Contribution Design and Data Collection

The 1991 inriver return of hatchery coho salmon originated from three major hatchery releases. In the first release, approximately 3.4 million coho salmon fry were released into the Little Susitna River drainage in 1988 (Appendix D1). Of the total released, approximately 1.9 million, 0.7 to

1.3 gram coho salmon fry were released in Nancy Lake. Approximately 12,000 (0.64%) of this release were implanted with a coded wire tag (CWT) and marked by clipping the adipose fin. Tag code B3-02-02 was assigned to this Nancy Lake fry release. The remaining 1.5 million fry were released in other Little Susitna River drainage lakes listed in Appendix D1. None of these fry were marked.

The second and third releases were smolt releases in the Little Susitna River drainage at Nancy Lake and Houston (Appendix D2). Approximately 308,400 coho salmon smolt, of which approximately 45,200 (14.7%) were tagged with a CWT and had their adipose fin removed, were released in the Little Susitna River drainage in 1990. To estimate the contribution of these stocked fish to the estimated 1991 sport harvest and the censused escapement (at rkm 52), all coho salmon harvested by boat anglers checked in the creel survey, and a portion of those passing upstream through the weir, were inspected for a missing adipose fin.

Tallies by day of both the number of fish examined and the number of fish having a missing adipose fin were kept. Heads were collected from whole fish in the harvest observed to have a missing adipose fin.

Inseason estimation of the hatchery produced coho salmon passing upstream of rkm 52 was required to project the escapement of 7,500 nonhatchery coho salmon to the spawning grounds upstream of the Parks Highway Bridge (rkm 112) as provided by the coho salmon management plan of 1990. To project this escapement at the weir, an average expected harvest of 500 nonhatchery coho upstream of the weir (Bartlett and Vincent-Lang 1989, Bartlett and Sonnichsen 1990, Bartlett and Bingham 1991) must be added to the estimation of nonhatchery coho salmon passing upstream of the weir. Therefore, an estimated 8,000 nonhatchery coho were allowed to pass upstream of the weir to satisfy escapement requirements. Nonhatchery coho were estimated for each 7-day stratum by subtracting the estimated hatchery contribution from the total escapement.

Hatchery Contribution Data Analysis

The contribution of stocked coho salmon to the sport harvest and at the weir was estimated with the assumption that the natural rate of a missing adipose fin in coho salmon stocks of the Little Susitna River was zero. Estimates were made on a 7-day combined stratum basis (i.e., combining weekday and weekend strata within each 7-day period). Chi-square tests (Sokal and Rohlf 1981) were used to test for differences in the numbers of marked fish observed by stratum to the estimated harvest for that stratum (for the type of day strata). Additionally, the estimated harvest of fish and the number of fish inspected for a missing adipose fin in each stratum were compared to determine if the proportions of inspected coho salmon at the survey locations were equal. Strata in which both tests indicated no significant difference were pooled (within 7-day periods). The contribution in numbers of fish and its variance were summed over all strata by location. The data collected at individual access sites were estimated separately and summed for a total contribution. The total estimated contribution, as a percent of the harvest, was the total estimated hatchery contribution from all sites divided by the total estimated harvest from all sites. The total estimated contribution as a

percent of the escapement was the total estimated contribution of all strata divided by the total number of coho salmon censused through the weir.

The estimated contribution of a release to the sport fishery and at the weir, including the variance, were calculated using the procedures outlined in Appendix D3. These procedures essentially follow the approach outlined by Clark and Bernard (1987) as modified by Conrad and Larson (1987). Conrad and Larson's modification of Clark and Bernard's procedures entail the incorporation of the variance due to estimating the overall harvest (both untagged and tagged stocks).

Note, that in the procedures outlined, I ignored the multi-stage nature of our sampling programs. My approach does incorporate the stratified nature of the program, however.

Smolt Stocking

In May 1991, approximately 277,800 coho salmon smolt were released into the Little Susitna River drainage (Appendix D2). Of the total released, approximately 189,000, 22.9 gram smolt were released in Nancy Lake near the outlet of Lilly Creek and approximately 88,700, 23.4 gram smolt were released in the mainstem river at Miller's Landing near Houston (Figure 1). Indicators of smolting, including behavior, color change, and blood sodium concentration, signaled the release. Two trips with the tanker truck were required to transport the Nancy Lake release and one trip with the tanker truck was required for the Houston release. Releases took place during late-evening hours in an attempt to reduce predation.

The smolt originated from 530,300 eggs collected during a 1989 egg take in Nancy Lake that were incubated at the Fort Richardson hatchery. As fry, the smolt were divided into two groups of approximately 140,000 fry each and reared in separate raceways using standard hatchery techniques (ADF&G 1983).

Approximately 30,200 (16%) of the Nancy Lake release and approximately 16,200 (18%) of the Houston release were implanted with a coded wire tag and marked by clipping the adipose fin. Tag code 31-19-35 was assigned to the Nancy Lake release and tag code 31-19-36 to the Houston release. To determine CWT retention during tagging, 200 smolt tagged the previous day were scanned for a CWT during each day of the tagging operation. The final percent tag retention was determined from a 500 smolt sample from each tag code just prior to release.

Egg Collection

Approximately 800,000 eggs were collected from 200 female coho salmon in Nancy Lake by seining near the mouth of Lilly Creek. Eighty females and 80 males were spawned on 23 September and 60 each were spawned on 25 and 27 September. Ripe fish were killed by striking them on the head with a club. Ripeness was determined by physical examination of the fish. Milt from five males was combined with eggs from five females in a 5 gallon plastic bucket. Water from Nancy Lake sufficient to cover the eggs was added to initiate fertilization. After 1 minute in the fertilization water, the eggs were rinsed, transferred to plastic bags, and placed in coolers to water harden for 45 to 90 minutes. The eggs were then iced, transported to Fort Richardson hatchery, and placed into incubators.

All coho salmon captured in the egg take were examined for a missing adipose fin. Heads were collected from all fish with a missing adipose fin and sent to the ADF&G tag lab in Juneau, Alaska for decoding. Egg collection field information was recorded in Rite in the Rain notebooks and transferred to standard FRED Division hatchery production forms before being transported to the hatchery. Smolt from this egg collection are scheduled to be reared in the Fort Richardson hatchery and released into the Little Susitna River during the spring of 1993. They will return as adults during the summer of 1994.

RESULTS

Creel Statistics

Direct expansion creel surveys were used to estimate the boat angler effort (in angler-hours), the catch rate, and the angler success at three major access points to the Little Susitna River coho salmon sport fishery.

Burma Road:

The number of boat anglers exiting the fishery at Burma Road during a surveyed period ranged from 0 to 110. Periods later in the fishing day were generally the busiest with respect to the number of anglers departing the fishery.

The total estimated effort during the coho salmon survey for all boat anglers exiting the sport fishery at Burma Road was 33,769 angler-hours (SE = 2,913) (Table 1). Hours of angler effort by 7-day stratum for all boat anglers exiting the fishery at Burma Road ranged from 1,125 to 13,184. The highest estimated effort occurred during the length-adjusted stratum from 6 August through 13 August. The lowest estimated effort was during the stratum from 27 August through 2 September.

The total estimated harvest of coho salmon by boat anglers exiting the fishery at Burma Road was 13,514 fish (SE = 1,292) (Table 2). An estimated 427 (SE = 73) coho salmon were harvested upstream of the weir (rkm 52). The estimated harvest of coho salmon by 7-day stratum for all boat anglers exiting the fishery at Burma Road ranged from 383 to 6,213. The highest number of fish estimated was during the length-adjusted stratum from 6 August through 13 August. The lowest estimated harvest was during the stratum from 16 July through 22 July.

The total estimated catch of coho salmon by boat anglers exiting the fishery at Burma Road was 17,580 fish (SE = 1,745) (Table 2). An estimated 672 (SE = 143) of these were caught upstream of the weir (rkm 52). The estimated catch of coho salmon by 7-day stratum for all boat anglers exiting the fishery at Burma Road ranged from 438 to 7,809. The highest number of fish estimated was during the length-adjusted stratum from 6 August through 13 August. The lowest number estimated was during the stratum from 16 July through 22 July.

Catch rates (per angler hour) by 7-day stratum of coho salmon for all boat anglers exiting the fishery at Burma Road ranged from 0.245 (SE = 0.035) to 1.390 (SE = 0.139) coho salmon (Table 3). The highest catch rate of coho salmon was during the stratum from 30 July through 5 August.

Table 1. Estimated effort by boat anglers exiting the Little Susitna River coho salmon sport fishery through the Burma Road access in 1991.

Date	Estimated Effort (angler-hours)	SE	Relative Precision (α = 0.05)	95% Confidence Interval
Downstream of weir:				
716-722	2,349	621	52%	1,132 - 3,566
723-729	4,100	1,200	57%	1,749 - 6,451
730-805	2,478	684	54%	1,137 - 3,818
806-813[a]	12,806	1,617	25%	9,637 - 15,975
814-819[a]	6,307	1,408	44%	3,545 - 9,066
820-826	2,944	525	35%	2,914 - 3,973
827-903	1,094	258	46%	589 - 1,599
Total	32,076	2,689	16%	26,805 - 37,347
Upstream of weir:				
716-722	10	8	152%	0 - 25
723-729	149	82	108%	0 - 310
730-805	515	395	150%	0 - 1,289
806-813[b]	375	181	94%	22 - 733
814-819[b]	340	161	93%	25 - 655
820-826	210	60	56%	92 - 328
827-903	31	18	113%	0 - 66
Total	1,633	475	57%	702 - 2,564
Combined[a]:				
716-722	2,419	601	49%	1,240 - 3,597
723-729	4,249	1,224	57%	1,812 - 6,687
730-805	2,993	993	65%	1,047 - 4,939
806-813[b]	13,184	1,758	26%	9,738 - 16,629
814-819[b]	6,646	1,448	43%	3,807 - 9,484
820-826	3,154	575	36%	2,026 - 4,281
827-903	1,125	265	46%	606 - 1,644
Total	33,769	2,913	17%	28,060 - 39,477

[a] The combined total was estimated independently and does not equal the sum of the downstream and upstream totals as a result.

[b] Strata adjusted to agree with a change in bag limit.

Table 2. Estimated harvest and catch of coho salmon by boat anglers exiting the Little Susitna River sport fishery through the Burma Road access in 1991.

Date	Estimated Harvest	SE	Relative Precision (α = 0.05)	95% Confidence Interval	Estimated Catch	SE	Relative Precision (α = 0.05)	95% Confidence Interval
Downstream of weir:								
716-722	380	80	41%	223 - 537	433	72	32%	293 - 573
723-729	1,050	329	61%	405 - 1,695	1,623	311	38%	1,013 - 2,233
730-805	858	188	43%	489 - 1,227	2,238	517	45%	1,224 - 3,252
806-813[a]	6,124	853	27%	4,452 - 7,796	7,629	1,343	35%	4,996 -10,262
814-819[a]	3,024	830	54%	1,397 - 4,651	3,219	895	54%	1,465 - 4,973
820-826	1,278	179	28%	926 - 1,630	1,370	189	27%	999 - 1,741
827-903	115	115	60%	151 - 603	416	124	58%	174 - 658
Total	13,091	1,270	19%	10,602 - 15,580	16,928	1,739	20%	13,519 - 20,337
Upstream of weir:								
716-722	3	2	127%	0 - 7	5	4	152%	0 - 13
723-729	50	29	112%	0 - 106	53	30	109%	0 - 111
730-805	20	15	152%	0 - 50	103	79	151%	0 - 259
806-813[a]	89	30	66%	31 - 147	181	88	95%	9 - 353
814-819[a]	124	45	71%	36 - 212	136	51	74%	36 - 236
820-826	124	36	58%	52 - 196	162	50	60%	65 - 259
827-903	17	10	110%	0 - 36	32	18	111%	0 - 68
Total	427	73	34%	283 - 571	672	143	42%	392 - 952

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Table 2. (Page 2 of 2).

Date	Estimated Harvest	SE	Relative Precision (α = 0.05)	95% Confidence Interval	Estimated Catch	SE	Relative Precision (α = 0.05)	95% Confidence Interval
Combined[b]:								
716-722	383	79	40%	229 - 537	438	68	31%	304 - 572
723-729	1,100	388	60%	437 - 1,763	1,675	331	39%	1,027 - 2,323
730-805	875	196	44%	292 - 1,258	2,325	566	48%	1,216 - 3,434
806-813[a]	6,213	858	27%	4,531 - 7,895	7,809	1,307	33%	5,248 -10,370
814-819[a]	3,148	846	53%	1,489 - 4,807	3,354	913	53%	1,564 - 5,144
820-826	1,402	210	29%	991 - 1,813	1,532	231	30%	1,080 - 1,984
827-903	393	119	59%	159 - 627	447	132	58%	188 - 706
Total	13,514	1,292	19%	10,982 - 16,046	17,580	1,745	19%	14,159 - 21,001

[a] Strata adjusted to agree with a change in bag limit.

[b] The combined total was estimated independently and does not equal the sum of the downstream and upstream totals as a result.

Table 3. Estimated catch rates of boat anglers exiting the Little Susitna River coho salmon sport fishery through the Burma Road access in 1991.

Date	CPUE (Catch per angler-hour)	SE
716-722	0.245	0.035
723-729	0.513	0.047
730-805	1.390	0.139
806-813[a]	0.808	0.029
814-819[a]	0.550	0.030
820-826	0.609	0.058
827-903	0.460	0.052
Total	0.714	0.176

[a] Length-adjusted strata to agree with a change in bag limit from three to five coho salmon.

Spanning the entire season, 63% (SE = 6%) of the anglers who fished upstream of the weir (rkm 52) were estimated to have harvested one or more coho salmon; 25% (SE = 6%) harvested two or more, and 11% (SE = 4%) harvested three or more (Table 4). Downstream of the weir, 79% (SE = 6%) of the anglers harvested one or more fish; 42% (SE = 5%) harvested two or more fish; 31% (SE = 4%) harvested three or more fish; 8% (SE = 2%) harvested four or more fish, and 6% (SE = 2%) harvested five or more fish. There were an estimated 8,031 boat angler trips exiting through the Burma Road access during 1991.

Boat anglers exiting the coho salmon sport fishery through Burma Road who fished downstream of the weir (rkm 52) released about 22.7% of the coho salmon they had caught (Table 5). Those fishing upstream of Burma Road and exiting through Burma Road released about 36.5% of the coho salmon they had caught (Table 6). The total release by boat anglers exiting the coho salmon sport fishery through Burma Road was about 23.1% (Table 7).

Catch rates (CPUE) per angler hour by 7-day stratum for guided and unguided anglers exiting the sport fishery through the Burma Road access were estimated (Table 8). The mean CPUE per 7-day stratum of guided boat anglers ranged from 0.475 (SE = 0.110) to 2.873 (SE = 0.371). The mean CPUE per 7-day stratum of unguided boat anglers ranged from 0.228 (SE = 0.036) to 1.198 (SE = 0.146). The extreme CPUE estimates for both groups occurred during the 16 July through 22 July stratum (lowest CPUE) and the 30 July through 5 August stratum (highest CPUE).

Spanning the entire season, 74% (SE not estimatable) of the guided anglers who fished upstream of the weir (rkm 52) and exited the fishery through Burma Road (Table 9) were estimated to have harvested one or more coho salmon and 17% (SE not estimatable) harvested two or more. Downstream of the weir, 94% (SE = 12%) of the guided anglers harvested one or more fish, 59% (SE = 12%) harvested two or more fish, 53% (SE = 12%) harvested three or more fish, 10% (SE = 3%) harvested four or more fish, and 9% (SE = 3%) harvested five or more fish.

Of the unguided anglers fishing upstream of the weir (Table 10), 62% (SE = 7%) harvested one or more fish, 24% (SE = 8%) harvested two or more fish, and 13% (SE = 5%) harvested three or more fish. An additional 1% (SE not estimatable) of the anglers reported harvesting more than three fish. Of the unguided anglers fishing downstream of the weir, 78% (SE = 6%) harvested one or more fish, 40% (SE = 4%) harvested two or more fish, 29% (SE = 4%) harvested three or more fish, 8% (SE = 1%) harvested four or more fish, and 6% (SE = 1%) harvested five or more fish.

The 1991 sport fishery was divided into periods of varying bag and possession limits in accordance with the coho salmon management plan as follows: three coho salmon from 1 January-20 July[5], one coho salmon from 21 July-5 August, three coho salmon from 6 August-1200 hours 14 August, and five coho salmon

[5] Although published in the Sport Fish Regulation Summary (ADF&G 1991) as a one coho salmon bag and possession limit, the bag and possession limit was actually three coho salmon by court order (Judge R. Cranston, Alaska Superior Court, Kenai, AK) until 0001 hours 21 July 1991. Few anglers were aware of the court order and, consequently, the majority of anglers abided by the published regulation.

Table 4. Estimates of the catch and harvest distribution of coho salmon by guided and unguided boat anglers exiting the Little Susitna River coho salmon sport fishery through the Burma Road access in 1991.

Estimated number of angler-trips	Parameter	Proportion of angler-trips that caught or harvested the noted number of coho salmon			
		Caught	SE	Harvested	SE
Upstream of weir[a]					
428.5	0 fish	0.3159	0.0300	0.3705	0.034
	1 or more fish	0.6841	0.0585	0.6295	0.056
	2 or more fish	0.3657	0.0608	0.2541	0.062
	3 or more fish	0.2180	0.0450	0.1100	0.037
	4 or more fish	0.0684	0.0341	0.0033	0.005
	5 or more fish	0.0359	0.0223	0.0000	0.000
	6 or more fish	0.0141	0.0041	0.0000	0.000
	7 or more fish	0.0071	0.0041	0.0000	0.000
	8 or more fish	0.0071	0.0041	0.0000	0.000
	9 or more fish	0.0000	0.0000	0.0000	0.000
	10 or more fish	0.0000	0.0000	0.0000	0.000
Downstream of weir[b]					
7,906.5	0 fish	0.1904	0.0206	0.2058	0.022
	1 or more fish	0.8096	0.0629	0.7942	0.060
	2 or more fish	0.5101	0.0493	0.4191	0.047
	3 or more fish	0.3810	0.0456	0.3050	0.043
	4 or more fish	0.1753	0.0241	0.0782	0.015
	5 or more fish	0.1242	0.0215	0.0611	0.015
	6 or more fish	0.0596	0.0131	0.0003	0.000
	7 or more fish	0.0382	0.0084	0.0003	0.000
	8 or more fish	0.0322	0.0082	0.0003	0.000
	9 or more fish	0.0197	0.0064	0.0002	0.000
	10 or more fish	0.0159	0.0058	0.0000	0.000

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Table 4. (Page 2 of 2).

Estimated number of angler-trips	Parameter	Proportion of angler-trips that caught or harvested the noted number of coho salmon: Caught	SE	Harvested	SE
Upstream and downstream of weir[b]					
8,031.0	0 fish	0.1856	0.0190	0.1984	0.020
	1 or more fish	0.8144	0.0640	0.8016	0.061
	2 or more fish	0.5158	0.0491	0.4245	0.047
	3 or more fish	0.3947	0.0444	0.3139	0.041
	4 or more fish	0.1850	0.0237	0.0807	0.015
	5 or more fish	0.1300	0.0208	0.0625	0.015
	6 or more fish	0.0628	0.0119	0.0003	0.000
	7 or more fish	0.0387	0.0081	0.0003	0.000
	8 or more fish	0.0322	0.0081	0.0003	0.000
	9 or more fish	0.0194	0.0063	0.0002	0.000
	10 or more fish	0.0157	0.0057	0.0000	0.000

[a] Maximum reported catch = 8 and maximum reported harvest = 4.

[b] Maximum reported catch = 18 and maximum reported harvest = 9.

Table 5. Summary of coho salmon released downstream of the weir (rkm 52) with an estimate of the angling induced mortality by boat anglers exiting the sport fishery through the Burma Road landing, 1991.

Dates	Catch	Harvest	Release	Percent Released	Mortality[a] #fish	Mortality[a] Percent[b]	Effort[c]	Bag Limit
716-722	433	380	53	12.2%	37	8.5%	2,349	3[d]
723-729	1,623	1,050	573	35.3%	395	24.3%	4,100	1
730-805	2,238	858	1,380	61.7%	952	42.5%	2,478	1
806-813	7,629	6,124	1,505	19.7%	1,038	13.6%	12,805	3
814-819	3,219	3,024	195	6.1%	135	4.2%	6,306	5
820-826	1,370	1,278	92	6.7%	63	4.9%	2,944	5
827-902	416	377	39	9.4%	27	6.5%	1,094	5
Totals	16,928	13,091	3,837	22.7%	2,648	15.6%	32,076	

[a] Mortality estimated at 69% from Vincent-Lang et al. (*In prep*).

[b] Estimated percent of catch.

[c] Effort in angler-hours.

[d] Bag limit changed from 3 to 1 coho salmon at 0001 hours 21 July.

Table 6. Summary of coho salmon released upstream of the weir (rkm 52) with an estimate of the angling induced mortality by boat anglers exiting the sport fishery through the Burma Road landing, 1991.

Dates	Catch	Harvest	Release	Percent Released	Mortality[a] #fish	Mortality[a] Percent[b]	Effort[c]	Bag Limit
716-722	5	3	2	40.0%	0	0.0%	10	3[d]
723-729	53	50	3	5.7%	0	0.0%	149	1
730-805	103	20	83	80.6%	10	9.7%	515	1
806-813	181	89	92	50.8%	11	6.1%	378	3
814-819	136	124	12	8.8%	1	0.7%	340	3
820-826	162	124	38	23.5%	5	3.1%	210	3
827-902	32	17	15	46.9%	2	6.3%	31	3
Totals	672	427	245	36.5%	29	4.3%	1,633	

[a] Mortality estimated at 12% from Vincent-Lang et al. (*In prep*).

[b] Estimated percent of catch.

[c] Effort in angler-hours.

[d] Bag limit changed from 3 to 1 coho salmon at 0001 hours 21 July.

Table 7. Summary of coho salmon released with an estimate of the angling induced mortality by boat anglers exiting the sport fishery through Burma Road landing, 1991.

Dates	Catch	Harvest	Release	Percent Released	Mortality[a] #fish	Mortality[a] Percent[b]	Effort[c]	Bag Limit[d]
716-722	438	383	55	12.6%	38	8.7%	2,419	3[e]
723-729	1,675	1,100	575	34.3%	397	23.7%	4,249	1
730-805	2,325	875	1,450	62.4%	1,001	43.1%	2,993	1
806-813	7,809	6,213	1,596	20.4%	1,101	14.1%	13,184	3
814-819	3,354	3,148	206	6.1%	142	4.2%	6,646	5
820-826	1,532	1,402	130	8.5%	90	5.9%	3,154	5
827-902	447	393	54	12.1%	37	8.3%	1,125	5
Totals	17,580	13,514	4,066	23.1%	2,806	16.0%	33,769	

[a] Mortality estimated at 69% for downstream of the weir only from Vincent-Lang et al. (*In prep*).

[b] Estimated percent of catch.

[c] Effort in angler-hours.

[d] Bag limit downstream of the weir only.

[e] Bag limit changed from 3 to 1 coho salmon at 0001 hours 21 July.

Table 8. Catch rates by stratum of guided and unguided coho salmon anglers exiting the sport fishery through the Little Susitna River Burma Road access in 1991.

Date	Guided Anglers CPUE (Catch per angler-hour)	SE	Unguided Anglers CPUE (Catch per angler-hour)	SE
716-722	0.475	0.110	0.228	0.036
723-729	0.687	0.068	0.486	0.054
730-805	2.873	0.371	1.198	0.146
806-813[a]	1.144	0.084	0.767	0.031
814-819[a]	0.785	0.158	0.522	0.027
820-826	0.865	0.070	0.597	0.061
827-903	0.908	0.125	0.441	0.054
Total	0.847	0.455	0.659	0.184

[a] Length adjusted strata to agree with a change in bag limit from three to five coho salmon.

Table 9. Estimates of the catch and harvest distribution of coho salmon by guided boat anglers exiting the Little Susitna River coho salmon sport fishery through the Burma Road access in 1991.

Estimated number of angler-trips	Parameter	Proportion of angler-trips that caught or harvested the noted number of coho salmon			
		Caught	SE	Harvested	SE
Upstream of weir[a]					
96.0	0 fish	0.260	----[b]	0.260	----[b]
	1 or more fish	0.740	----[b]	0.740	----[b]
	2 or more fish	0.219	----[b]	0.167	----[b]
	3 or more fish	0.219	----[b]	0.167	----[b]
	4 or more fish	0.052	----[b]	0.000	----[b]
	5 or more fish	0.052	----[b]	0.000	----[b]
	6 or more fish	0.052	----[b]	0.000	----[b]
	7 or more fish	0.052	----[b]	0.000	----[b]
	8 or more fish	0.052	----[b]	0.000	----[b]
	9 or more fish	0.000	----[b]	0.000	----[b]
	10 or more fish	0.000	----[b]	0.000	----[b]
Downstream of weir[c]					
748.0	0 fish	0.034	0.017	0.056	0.027
	1 or more fish	0.966	0.119	0.944	0.117
	2 or more fish	0.836	0.121	0.585	0.117
	3 or more fish	0.742	0.121	0.529	0.118
	4 or more fish	0.377	0.099	0.103	0.026
	5 or more fish	0.271	0.060	0.089	0.025
	6 or more fish	0.140	0.047	0.000	0.000
	7 or more fish	0.125	0.046	0.000	0.000
	8 or more fish	0.117	0.044	0.000	0.000
	9 or more fish	0.046	0.014	0.000	0.000
	10 or more fish	0.040	0.012	0.000	0.000

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Table 9. (Page 2 of 2).

Estimated number of angler-trips	Parameter	Proportion of angler-trips that caught or harvested the noted number of coho salmon			
		Caught	SE	Harvested	SE
Upstream and downstream of weir[c]					
836.5	0 fish	0.029	0.015	0.045	0.028
	1 or more fish	0.971	0.111	0.955	0.108
	2 or more fish	0.807	0.110	0.579	0.106
	3 or more fish	0.720	0.110	0.510	0.103
	4 or more fish	0.443	0.085	0.123	0.023
	5 or more fish	0.325	0.053	0.098	0.026
	6 or more fish	0.177	0.050	0.000	0.000
	7 or more fish	0.133	0.043	0.000	0.000
	8 or more fish	0.110	0.041	0.000	0.000
	9 or more fish	0.042	0.014	0.000	0.000
	10 or more fish	0.037	0.013	0.000	0.000

[a] Maximum reported catch = 8 and maximum reported harvest = 3.

[b] Anglers were only interviewed in one temporal component of survey, as such overall SE's were not estimable.

[c] Maximum reported catch = 16 and maximum reported harvest = 5.

Table 10. Estimates of the catch and harvest distribution of coho salmon by unguided boat anglers exiting the Little Susitna River coho salmon sport fishery through the Burma Road access in 1991.

Estimated number of angler-trips	Parameter	Proportion of angler-trips that caught or harvested the noted number of coho salmon			
		Caught	SE	Harvested	SE
Upstream of weir[a]					
179.5	0 fish	0.353	0.000	0.378	0.000
	1 or more fish	0.647	0.068	0.622	0.068
	2 or more fish	0.313	0.080	0.241	0.077
	3 or more fish	0.194	0.077	0.127	0.052
	4 or more fish	0.116	0.077	0.014	0.000
	5 or more fish	0.058	0.051	0.000	0.000
	6 or more fish	0.000	0.000	0.000	0.000
	7 or more fish	0.000	0.000	0.000	0.000
	8 or more fish	0.000	0.000	0.000	0.000
	9 or more fish	0.000	0.000	0.000	0.000
	10 or more fish	0.000	0.000	0.000	0.000
Downstream of weir[b]					
7,016.5	0 fish	0.205	0.022	0.217	0.023
	1 or more fish	0.795	0.059	0.783	0.057
	2 or more fish	0.476	0.043	0.404	0.042
	3 or more fish	0.347	0.039	0.289	0.037
	4 or more fish	0.149	0.019	0.075	0.012
	5 or more fish	0.105	0.017	0.057	0.011
	6 or more fish	0.052	0.012	0.000	0.000
	7 or more fish	0.029	0.007	0.000	0.000
	8 or more fish	0.023	0.007	0.000	0.000
	9 or more fish	0.018	0.007	0.000	0.000
	10 or more fish	0.014	0.006	0.000	0.000

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Table 10. (Page 2 of 2).

Estimated number of angler-trips	Parameter	Proportion of angler-trips that caught or harvested the noted number of coho salmon: Caught	SE	Harvested	SE
Upstream and downstream of weir[b]					
7,194.5	0 fish	0.206	0.021	0.218	0.022
	1 or more fish	0.794	0.060	0.782	0.057
	2 or more fish	0.477	0.044	0.404	0.042
	3 or more fish	0.350	0.039	0.291	0 037
	4 or more fish	0.150	0.019	0.075	0.012
	5 or more fish	0.106	0.017	0.058	0.011
	6 or more fish	0.052	0.012	0.000	0.000
	7 or more fish	0.027	0.007	0.000	0.000
	8 or more fish	0.023	0.007	0.000	0.000
	9 or more fish	0.018	0.006	0.000	0.000
	10 or more fish	0.014	0.006	0.000	0.000

[a] Maximum reported catch = 5 and maximum reported harvest = 4.

[b] Maximum reported catch = 18 and maximum reported harvest = 9.

downstream of the weir (rkm 52) from 1201 hours 14 August-31 December. Regulation (ADF&G 1991) also prohibited anglers from fishing the waters of the Little Susitna River for any species once the daily bag limit of salmon was in possession. To estimate the impact of the management plan on the sport fishery, harvest success data are more meaningfully grouped by bag and possession limits.

Harvest success in terms of the proportion of anglers harvesting 0, 1, 2, 3, or more coho salmon grouped by bag and possession limits are presented in Table 11. The data presented ignore a court order rescinding the published (ADF&G 1991) one coho salmon bag and possession limit and reinstating a three fish bag and possession limit until 21 July because the majority of anglers were not aware of the court order and abided by the one fish bag and possession limit. The one fish bag limit will therefore be considered to span the period from 16 July through 5 August. The fact that some anglers were aware of the court ordered three fish bag and possession limit, and took advantage of it, is evident in the small proportion of anglers fishing downstream of the weir who harvested more than one fish during this period. The upstream-of-the-weir portion of the harvest success data during the one fish period includes only those anglers exiting the survey through Burma Road because the Miller's Landing and Miller's Reach fisheries did not start until after the three fish bag and possession limit was in effect.

During the one fish bag and possession limit, 100% of the guided anglers fishing upstream of the weir were successful in filling the bag and possession limit (Table 11). The small number of angler trips (20) did not allow a valid comparison between guided and unguided anglers.

During the three fish bag and possession limit upstream of the weir (Table 11), approximately 20% of both guided and unguided anglers filled their bag limit. During the three fish bag and possession limit downstream of the weir, 91% (SE = 27%) of guided anglers were successful in filling the bag and possession limit, while only 46% (SE = 9%) of the unguided anglers filled the limit.

At 1200 hours on 14 August, the bag and possession limit was raised by two coho salmon (five total) downstream of the weir (rkm 52) to harvest surplus hatchery fish. With the increased limit, 41% (SE = 11%) of the guided anglers filled their bag limit. Within the unguided anglers fishing downstream of the weir during the five fish bag and possession limit, 19% (SE = 4) filled their bag limit.

Miller's Landing and Reach:

The number of boat anglers exiting the fishery at Miller's Landing and Reach during a surveyed period ranged from 0 to 14. Periods later in the fishing day were generally the busiest with respect to the number of anglers departing the fishery. Estimated angler effort during the survey for boat anglers exiting the fishery at Miller's Landing was 1,722 angler-hours (SE = 346) (Table 12). Estimated angler effort during the survey for boat anglers exiting the fishery at Miller's Reach was 920 (SE = 224) angler-hours. The total estimated effort for both survey locations was 2,642 (SE = 412) angler-hours.

Table 11. Estimates of the catch and harvest distribution of coho salmon by guided and unguided boat anglers exiting the Little Susitna River coho salmon sport fishery through the Burma Road access in 1991.

	Estimated number of angler-trips	Parameter	Proportion of angler-trips that caught or harvested the noted number of coho salmon			
			Caught	SE	Harvested	SE
Upstream of weir						
1 Fish Bag Limit (16 July-5 Aug):						
Guided Anglers	20.0	0 fish	0.000	----[a]	0.000	----[a]
		1 or more fish	1.000	----[a]	1.000	----[a]
		2 or more fish	0.250	----[a]	0.000	----[a]
		3 or more fish	0.250	----[a]	0.000	----[a]
Unguided Anglers	77.5	0 fish	0.419	0.000	0.419	0.000
		1 or more fish	0.581	0.000	0.581	0.000
		2 or more fish	0.089	0.033	0.000	0.000
		3 or more fish	0.000	0.000	0.000	0.000
Guided and Unguided Anglers	107.5	0 fish	0.441	0.041	0.441	0.041
		1 or more fish	0.559	0.041	0.559	0.041
		2 or more fish	0.085	0.025	0.000	0.000
		3 or more fish	0.028	0.016	0.000	0.000
3 Fish Bag Limit (6 Aug-2 Sept):						
Guided Anglers	76.0	0 fish	0.329	----[a]	0.329	----[a]
		1 or more fish	0.671	----[a]	0.671	----[a]
		2 or more fish	0.211	----[a]	0.211	----[a]
		3 or more fish	0.211	----[a]	0.211	----[a]
		4 or more fish	0.000	----[a]	0.000	----[a]
		5 or more fish	0.000	----[a]	0.000	----[a]
		6 or more fish	0.000	----[a]	0.000	----[a]
Unguided Anglers	102.0	0 fish	0.303	0.000	0.347	0.000
		1 or more fish	0.697	0.120	0.653	0.120
		2 or more fish	0.483	0.138	0.425	0.136
		3 or more fish	0.341	0.136	0.224	0.091
		4 or more fish	0.205	0.135	0.025	0.000
		5 or more fish	0.102	0.090	0.000	0.000
		6 or more fish	0.000	0.000	0.000	0.000

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Table 11. (Page 2 of 4).

	Estimated number of angler-trips	Parameter	Proportion of angler-trips that caught or harvested the noted number of coho salmon			
			Caught	SE	Harvested	SE
Guided and Unguided Anglers	321.0	0 fish	0.274	0.038	0.347	0.044
		1 or more fish	0.726	0.077	0.653	0.073
		2 or more fish	0.460	0.081	0.339	0.083
		3 or more fish	0.282	0.060	0.147	0.049
		4 or more fish	0.082	0.045	0.004	0.006
		5 or more fish	0.038	0.029	0.000	0.000
		6 or more fish	0.009	0.000	0.000	0.000
Downstream of weir						
1 Fish Bag Limit (16 July-5 Aug):						
Guided Anglers	277.5	0 fish	0.063	0.022	0.073	0.022
		1 or more fish	0.937	0.067	0.927	0.067
		2 or more fish	0.719	0.090	0.041	0.035
		3 or more fish	0.563	0.092	0.027	0.038
Unguided Anglers	2,215.0	0 fish	0.171	0.033	0.194	0.035
		1 or more fish	0.829	0.108	0.806	0.095
		2 or more fish	0.236	0.043	0.054	0.017
		3 or more fish	0.140	0.034	0.035	0.014
Guided and Unguided Anglers	2,502.5	0 fish	0.164	0.029	0.185	0.031
		1 or more fish	0.837	0.112	0.815	0.101
		2 or more fish	0.295	0.053	0.054	0.017
		3 or more fish	0.200	0.040	0.036	0.013
3 Fish Bag Limit (6 Aug-13 Aug):						
Guided Anglers	308.8	0 fish	0.000	0.000	0.000	0.000
		1 or more fish	1.000	0.270	1.000	0.270
		2 or more fish	0.989	0.272	0.989	0.272
		3 or more fish	0.942	0.270	0.908	0.272
		4 or more fish	0.247	0.217	0.000	0.000
		5 or more fish	0.113	0.106	0.000	0.000
		6 or more fish	0.057	0.085	0.000	0.000

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Table 11. (Page 3 of 4).

	Estimated number of angler-trips	Parameter	Proportion of angler-trips that caught or harvested the noted number of coho salmon			
			Caught	SE	Harvested	SE
Unguided Anglers	2,652.5	0 fish	0.150	0.035	0.155	0.036
		1 or more fish	0.850	0.103	0.845	0.103
		2 or more fish	0.649	0.098	0.621	0.100
		3 or more fish	0.501	0.089	0.456	0.089
		4 or more fish	0.106	0.020	0.000	0.000
		5 or more fish	0.052	0.021	0.000	0.000
		6 or more fish	0.045	0.025	0.000	0.000
Guided and Unguided Anglers	3,028.8	0 fish	0.136	0.034	0.140	0.035
		1 or more fish	0.864	0.109	0.860	0.109
		2 or more fish	0.678	0.110	0.653	0.113
		3 or more fish	0.529	0.105	0.484	0.102
		4 or more fish	0.124	0.031	0.000	0.000
		5 or more fish	0.061	0.028	0.000	0.000
		6 or more fish	0.044	0.024	0.000	0.000
Downstream of weir						
5 Fish Bag Limit (14 Aug-2 Sept):						
Guided Anglers	161.8	0 fish	0.049	0.069	0.136	0.117
		1 or more fish	0.951	0.158	0.864	0.124
		2 or more fish	0.747	0.129	0.747	0.128
		3 or more fish	0.666	0.153	0.666	0.153
		4 or more fish	0.475	0.119	0.475	0.119
		5 or more fish	0.421	0.116	0.411	0.114
		6 or more fish	0.000	0.000	0.000	0.000
		7 or more fish	0.000	0.000	0.000	0.000
		8 or more fish	0.000	0.000	0.000	0.000
Unguided Anglers	2,149.0	0 fish	0.309	0.047	0.317	0.048
		1 or more fish	0.691	0.096	0.683	0.095
		2 or more fish	0.510	0.058	0.496	0.053
		3 or more fish	0.368	0.053	0.344	0.047
		4 or more fish	0.261	0.040	0.245	0.038
		5 or more fish	0.200	0.037	0.187	0.035
		6 or more fish	0.047	0.010	0.001	0.002
		7 or more fish	0.023	0.004	0.001	0.002
		8 or more fish	0.016	0.003	0.001	0.002

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Table 11. (Page 4 of 4).

	Estimated number of angler-trips	Parameter	Proportion of angler-trips that caught or harvested the noted number of coho salmon			
			Caught	SE	Harvested	SE
Guided and Unguided Anglers	2,375.3	0 fish	0.288	0.043	0.312	0.048
		1 or more fish	0.712	0.103	0.688	0.097
		2 or more fish	0.523	0.064	0.506	0.061
		3 or more fish	0.383	0.059	0.361	0.056
		4 or more fish	0.275	0.052	0.260	0.050
		5 or more fish	0.216	0.051	0.203	0.049
		6 or more fish	0.041	0.009	0.001	0.001
		7 or more fish	0.019	0.004	0.001	0.001
		8 or more fish	0.014	0.003	0.001	0.001

[a] Too few anglers were viewed within noted temporal component grouping, as such overall SE's were not estimable.

Table 12. Estimated effort by boat anglers exiting the Little Susitna River coho salmon sport fishery through the Miller's Landing and Reach accesses in 1991.

Date	Estimated Effort (angler-hrs)	SE	Relative Precision (α = 0.05)	95% Confidence Interval
Miller's Landing:				
809-812	303	191	124%	0 - 678
813-819	563	185	64%	201 - 925
820-826	603	172	56%	265 - 941
827-902	253	138	106%	0 - 523
Total	1,722	346	39%	1,045 - 2,399
Miller's Reach:				
809-812	436	170	76%	103 - 768
813-819	111	56	99%	1 - 220
820-826	172	35	40%	103 - 240
827-902	203	130	126%	0 - 458
Total	920	224	48%	481 - 1,359
Miller's Landing and Reach Combined:				
809-812	738	256	68%	237 - 1.240
813-819	674	193	56%	295 - 1,052
820-826	775	176	44%	430 - 1,119
827-902	456	189	81%	84 - 827
Combined Total	2,642	412	31%	1,835 - 3,449

Total estimated harvest for both survey locations was 565 (SE = 113) coho salmon; most of these fish were harvested at Miller's Landing (417, SE = 101) (Table 13). Catch rates per angler hour (CPUE) of coho salmon for boat anglers exiting the fishery at Miller's Landing and Reach ranged from 0.097 (SE = 0.029) to 0.313 (SE = 0.043) fish per hour (Table 14). The highest CPUE of coho salmon estimated was by anglers exiting the fishery from 20 August through 26 August.

Spanning the entire season, 41% (SE = 6%) of the anglers were estimated to have harvested one or more coho salmon, 27% (SE = 4%) harvested two or more, and 19% (SE = 3%) three or more (Table 15). A three fish bag and possession limit was in effect during the surveyed Miller's Landing and Reach sport fishery. Anglers released about 15% (99 fish) of the coho salmon they caught (Table 16).

Creel Estimates Summary:

The total estimated effort for boat anglers exiting the sport fishery through all three Little Susitna River coho salmon survey locations combined was 36,411 (SE = 2,942) angler-hours. A total of 14,079 (SE = 1,297) coho salmon were harvested from a total catch of 18,244 (SE = 1,750). Boat anglers exiting the fishery through the Burma Road access site were responsible for 93% of the estimated angler effort, 96% of the estimated coho salmon harvest, and 96% of the estimated coho salmon catch. Boat anglers exiting the fishery at the Miller's access sites had 7% of the effort, 4% of the harvest, and 4% of the catch.

Escapement Statistics

From 25 July through 16 September, 39,241 coho salmon, 9,897 chum salmon *O. keta*, 9,377 sockeye salmon *O. nerka*, and 119 pink salmon *O. gorbuscha* were passed through the weir at rkm 52 (Appendix E1). Thirty-nine chinook salmon *O. tshawytscha* were also passed but the count for this species was incomplete because the run timing does not coincide with the placement of the weir.

The counted escapement of coho salmon through the weir adjusted for the estimated harvest by sport anglers fishing upstream of the weir and exiting the sport fishery through Burma Road, and Miller's Landing and Reach, was 38,249 fish (SE = 135). Fifty percent of the coho salmon passage through the weir (19,621 fish) occurred on 17 August (Appendix E).

Coho escapement through the weir in 1991, adjusted for the upstream harvest component, represents almost the entire escapement to the Little Susitna River. Inspection of the river under excellent visibility conditions downstream of the weir prior to its removal on 17 September indicated only a few coho salmon holding in areas of the river which normally contain hundreds of fish. It is doubtful that significant numbers of fish passed the weir before or after it was removed. The unestimated harvest upstream of the weir is also believed minimal and coho salmon are not known to spawn downstream of the weir. The aerial count of coho salmon spawning escapement to index areas on the Little Susitna River totaled 5,250 fish.

Table 13. Estimated harvest and catch of coho salmon by boat anglers exiting the Little Susitna River sport fishery through Miller's Landing and Reach accesses in 1991.

Date	Estimated Harvest	SE	Relative Precision (α = 0.05)	95% Confidence Interval	Estimated Catch	SE	Relative Precision (α = 0.05)	95% Confidence Interval
Miller's Landing:								
809-812	63	38	117%	0 - 137	63	38	117%	0 - 137
813-819	173	70	79%	36 - 310	185	69	74%	49 - 321
820-826	156	60	76%	38 - 274	203	73	70%	60 - 346
827-902	25	14	109%	0 - 52	25	14	109%	0 - 52
Total	417	101	47%	220 - 614	476	108	45%	264 - 688
Miller's Reach:								
809-812	11	10	172%	0 - 30	11	10	172%	0 - 30
813-819	11	10	172%	0 - 30	11	10	172%	0 - 30
820-826	45	12	53%	21 - 69	51	14	88%	24 - 78
827-902	81	48	117%	0 - 176	115	71	121%	0 - 254
Total	148	52	87%	15 - 213	188	73	76%	44 - 332
Miller's Landing and Reach Combined:								
809-812	74	39	103%	0 - 150	74	39	103%	0 - 150
813-819	184	71	75%	45 - 323	196	70	70%	49 - 333
820-826	201	62	60%	80 - 322	254	74	57%	91 - 399
827-902	106	50	93%	7 - 205	140	72	101%	0 - 281
Combined Total	565	113	39%	310 - 752	664	131	39%	408 - 920

Table 14. Estimated catch rates by boat anglers exiting the Little Susitna River coho salmon sport fishery through the Miller's Landing and Reach accesses in 1991.

Strata	CPUE (Catch per angler-hour)	SE
Miller's Landing:		
809-812	0.172	0.049
813-819	0.320	0.050
820-826	0.346	0.047
827-902	0.760	0.029
Total	0.184	0.089
Miller's Reach:		
809-812	0.007	0.005
813-819	0.036	0.026
820-826	0.257	0.085
827-902	0.396	0.066
Total	0.193	0.110
Miller's Landing and Reach Combined:		
809-812	0.097	0.029
813-819	0.239	0.041
820-826	0.313	0.043
827-902	0.224	0.042
Combined Total	0.227	0.079

Table 15. Estimates of the catch and harvest distribution of coho salmon by all boat anglers exiting the Little Susitna River coho salmon sport fishery through the Miller's Reach and Landing accesses in 1991.

	Estimated number of angler-trips	Parameter	Proportion of angler-trips that caught or harvested the noted number of coho salmon			
			Caught	SE	Harvested	SE
Miller's Reach and Landing Combined						
3 Fish Bag Limit (6 Aug - 2 Sept):						
Guided and Unguided Anglers Combined	282.0	0 fish	0.563	0.040	0.589	0.042
		1 or more fish	0.437	0.062	0.411	0.059
		2 or more fish	0.308	0.041	0.267	0.037
		3 or more fish	0.200	0.035	0.187	0.033
		4 or more fish	0.044	0.012	0.005	0.002
		5 or more fish	0.026	0.011	0.000	0.000
		6 or more fish	0.020	0.011	0.000	0.000

Table 16. Summary of coho salmon released with an estimate of the angling induced mortality by boat anglers exiting the sport fishery through Miller's Landing and Reach, 1991.

Dates	Catch	Harvest	Release	Percent Released	Mortality[a] #fish	Mortality[a] Percent[b]	Effort (angler-hours)	Bag Limit
809-812	74	74	0				738	3
813-819	196	184	12	6.1%	1	0.5%	674	3
820-826	254	201	53	20.9%	6	2.4%	775	3
827-902	140	106	34	24.3%	4	2.9%	456	3
Totals	664	565	99	14.9%	12	1.8%	2,642	

[a] Mortality estimated at 12% from Vincent-Lang et al. (*In prep*).

[b] Estimated percent of catch.

Size, Sex, and Age Compositions

A total of 419 coho salmon from the Burma Road sport harvest (3.1% of the estimated harvest) were sexed and aged. Females and males represented 49% (SE = 5%) and 51% (SE = 5%) of the estimated harvest, respectively (Table 17). Age-1.1 coho salmon were the most abundant age group comprising 80% (SE = 7%) of the estimated harvest. The remaining harvest was comprised of age groups 2.1 and 3.1, in descending order.

A total of 452 coho salmon from the escapement past the weir (1.2%) were sexed and their scales aged. Females and males represented 40% (SE = 4%) and 60% (SE = 5%) of the escapement, respectively (Table 18). Age 2.1 (61%, SE = 3%) and 1.1 (37%, SE = 3) were the most abundant age groups in the escapement.

Age composition within the fish sampled was significantly different ($\alpha = 0.05$) between the Burma Road harvest and the escapement within ages 1.1 ($\chi^2 = 210.8$ with 1 degree of freedom) and 2.1 ($\chi^2 = 205.2$ with 1 degree of freedom). There were, however, no significant differences between age 3.1 ($\chi^2 = 0.6$ with 1 degree of freedom) fish.

Sex ratios from the Burma Road harvest and the weir were compared. Within six comparable 7-day strata, a significant difference ($\alpha = 0.05$) in the sex ratio existed only during the 20 August through 26 August stratum ($\chi^2 = 9.0$ with 1 degree of freedom) in which males dominated the escapement and females the harvest.

The sex of 2,471 coho salmon checked through the creel survey at Burma Road was recorded when they were inspected for hatchery marks. The sex of ratios of coho salmon within each 7-day strata in this sample were compared with a chi-square test ($\alpha = 0.05$) to those from the age and sex composition samples taken from the Burma Road harvest and the escapement at the weir. The sex ratios of coho salmon in both Burma Road samples were not significantly different, i.e., observed at the same ratios in the harvest by 7-day strata. As with the comparison of the Burma Road age and sex composition sample with the escapement sample, a significant difference was observed only during the 20 August through 26 August stratum ($\chi^2 = 14.4$ with 1 degree of freedom).

The mean length in millimeters by sex of coho salmon from the Burma Road harvest (Table 19) and from the weir (Table 20) were compared with a two-tailed t-test ($\alpha = 0.05$). The mean length of age-1.1 female coho salmon sampled from the harvest and at the weir was significantly different ($t = 2.2$ with 204 degrees of freedom) with the larger fish in the escapement. Age-1.1 males sampled from the harvest and at the weir were not significantly different, but age-2.1 males ($t = 4.1$ with 212 degrees of freedom) and females ($t = 3.1$ with 188 degrees of freedom) were significantly different with the larger age-2.1 fish again in the escapement. Age-3.1 males and females were not significantly different at $\alpha = 0.05$.

A total of 27 coho salmon from the Miller's Landing sport harvest were sexed and their scales aged. Females and males represented 30% (SE = 9%) and 70% (SE = 13%) of the estimated harvest, respectively (Table 21). Age-1.1 coho salmon comprised 67% (SE = 9%) of the estimated harvest and age group 2.1 males comprised the remainder.

Table 17. Estimated sex and age composition of coho salmon from the Little Susitna River Burma Road sport fishery harvest in 1991.

	Age Group			
	1.1	2.1	3.1	Total
Females:				
Estimated Harvest	5,365	1,132	162	6,660
SE	796.1	268.3	106.8	846.9
Percent	39.7	8.4	1.2	49.3
SE (%)	4.5	1.8	0.8	4.9
Males:				
Estimated Harvest	5,479	1,323	52	6,854
SE	807.6	303.5	27.6	863.2
Percent	40.5	9.8	0.4	50.7
SE (%)	4.6	2.1	0.2	5.0
Sexes Combined:				
Estimated Harvest	10,844	2,455	214	13,514
SE	1,388.1	441.2	111.0	1,460.7
Percent	80.3	18.2	1.6	100.0
SE (%)	6.9	2.8	0.8	

Table 18. Estimated sex and age composition of coho salmon from the Little Susitna River escapement through the weir in 1991.

	Age Group			
	1.1	2.1	3.1	Total
Females:				
Estimated Harvest	3,671	11,373	489	15,533
SE	796.4	1,224.7	350.7	1,502.4
Percent	9.4	29.0	1.3	39.6
SE (%)	2.0	3.1	0.9	3.8
Males:				
Estimated Harvest	10,833	12,559	316	23,708
SE	1,326.4	1,233.4	141.5	1,816.8
Percent	27.6	32.0	0.8	60.4
SE (%)	3.4	3.1	0.4	4.6
Sexes Combined:				
Estimated Harvest	14,504	23,932	805	39,241
SE	1,373.6	1,379.1	377.7	1,982.8
Percent	37.0	61.0	2.1	100.0
SE (%)	3.5	3.5	1.0	

Table 19. Mean length of coho salmon by sex and age group sampled from the Little Susitna River Burma Road sport fishery in 1991.

	Age Group		
	1.1	2.1	3.1
Females:			
Mean Length (mm)[a]	566	580	572
SE	3	6	32
Sample Size	160	42	3
Minimum	410	455	515
Maximum	655	650	625
Males:			
Mean Length (mm)[a]	578	580	613
SE	3	7	17
Sample Size	162	47	4
Minimum	430	435	565
Maximum	680	680	645

[a] Mid-eye to fork of tail.

Table 20. Mean length of coho salmon by sex and age group sampled from the escapement at the Little Susitna River weir in 1991.

	Age Group		
	1.1	2.1	3.1
Females:			
Mean Length (mm)[a]	579	596	594
SE	4	2	13
Sample Size	46	148	5
Minimum	510	510	550
Maximum	625	650	620
Males:			
Mean Length (mm)[a]	588	605	597
SE	5	3	8
Sample Size	80	167	5
Minimum	445	460	575
Maximum	680	670	620

[a] Mid-eye to fork of tail.

Table 21. Estimated sex and age composition of coho salmon from the Little Susitna River, Miller's Landing and Reach sport fishery harvest in 1991.

	Age Group		
	1.1	2.1	Total
Females:			
Estimated Harvest	167		167
SE	58.9		58.9
Percent	29.6		29.6
SE (%)	8.7		8.7
Males:			
Estimated Harvest	209	188	398
SE	66.2	62.6	91.1
Percent	37.0	33.3	70.4
SE (%)	9.2	9.0	12.9
Sexes Combined:			
Estimated Harvest	377	188	565
SE	90.5	62.6	110.1
Percent	66.7	33.3	100.0
SE (%)	9.0	9.0	

Age composition was compared between samples collected from the Miller's survey sites (Table 22) and at the weir with a chi-square test ($\alpha = 0.05$). Significant differences in age-1.1 ($\chi^2 = 18.2$ with 1 degree of freedom) and age-2.1 ($\chi^2 = 15.4$ with 1 degree of freedom) coho salmon from the Miller's sample and the weir sample were observed. There were no significant differences observed between age-1.1 or -2.1 fish from the Miller's and Burma Road harvests. There were no age-3.1 coho salmon in the Miller's Landing and Miller's Reach age composition sample to compare.

The mean length (mid-eye to fork-of-tail) in millimeters by sex of coho salmon in the age, sex, and length composition samples from the Miller's harvest, Burma Road harvest, and the escapement at the weir were compared with a two-tailed t-test ($\alpha = 0.05$). Miller's age-1.1 females were significantly different from Burma Road age-1.1 females ($t = 2.1$ with 166 degrees of freedom) with Miller's females being the largest. Miller's age-1.1 or -2.1 males were not significantly different from Burma Road age-1.1 or -2.1 males. There were no age-2.1 females in the Miller's sample to compare.

Miller's age-1.1 males or females were not significantly different from age-1.1 males or females sampled at the weir. Miller's age-2.1 males were significantly different ($t = 2.3$ with 174 degrees of freedom) from age-2.1 males sampled at the weir. The larger age-2.1 males were sampled at the weir. The Miller's sample was small, however, with 8 age-1.1 females, 10 age-1.1 males, and 9 age-2.1 males.

Hatchery Contributions

Of a total of 3,585 coho salmon examined from the Burma Road sport fishery, 207 had a missing adipose fin (Table 23). Of these, 157 heads were removed and sent to the FRED Division CWT lab for processing. A total of 148 fish had CWT's present that could be decoded. Decodeable tags were recovered from five hatchery releases: a 1988 fry release from Little Susitna brood, two 1990 smolt releases from Little Susitna brood, the 1989 smolt release from Little Susitna brood, and the 1990 Whittier (Prince William Sound) smolt release from Fleming Spit brood. Chi-square tests comparing the estimated sport harvest by boat anglers exiting through the Burma Road landing to the number of fish examined for a missing adipose fin and the number of fish observed with a missing adipose fin within the 14 strata indicated that significant differences ($\alpha = 0.05$) were present between all strata. The hatchery contribution for each of the 14 strata was therefore, estimated separately and summed (with each respective variance) for a total estimated hatchery contribution of 6,531 (SE = 1,205) fish to the sport harvest (Table 24).

Based on these data, the estimated contribution of hatchery-produced coho salmon represents 48.3% of the total estimated Burma Road harvest (13,514; SE = 1,292).

An estimated 71% percent of the total 1991 hatchery contribution of 6,531 fish to the Burma Road boat angler sport harvest originated from the two major 1990 smolt releases at Nancy Lake and Houston. The Nancy Lake release contributed 64% and the Houston release contributed 36% of the estimated total 4,646 (SE = 518) fish contributed from these two smolt releases. An additional 28% originated from the 1988 Nancy Lake fry release. The remaining 1% originated from the 1989 Nancy Lake smolt release and from the 1990 Whittier release of Fleming Spit brood.

Table 22. Mean length of coho salmon by sex and age group sampled from the Little Susitna River Miller's Landing and Reach sport fishery in 1991.

	Age Group	
	1.1	2.1
Females:		
Mean Length (mm)[a]	593	
SE	9	
Sample Size	8	
Minimum	560	
Maximum	620	
Males:		
Mean Length (mm)[a]	582	578
SE	15	16
Sample Size	10	9
Minimum	500	520
Maximum	635	645

[a] Mid-eye to fork of tail.

Table 23. Little Susitna River Burma Road coho salmon coded wire tag recovery summary by release and survey strata, 16 July through 2 September 1991.

Strata	Dates of Survey	Heads W/CWT	Dec[a] CWT	Clips[b] Obser.	Heads To Lab	Estimated Harvest	Variance	Number Inspected	Unique Code[c] NL	H	FR	89	FS	Total	Tagging Proportion
1	716,17,18,22	0	0	0	0	5	20.00	0						0	NL = 0.1462
2	719,20,21	2	2	2	2	378	6,161.25	120		1		1		2	H = 0.1476
3	723,24,25,29	0	0	0	0	570	90,800.00	76						0	FR = 0.0064
4	726,27,28	1	1	2	2	530	23,572.50	170	1					1	89 = 0.7150
5	730,31,801,05	0	0	0	0	315	6,950.00	63						0	FS = 0.2107
6	802,03,04	8	8	8	8	560	31,312.50	211	6	2				8	
7[d]	806,07,08,12,13	18	18	23	18	3,350	515,437.50	586	13	5				18	
8	809,10,11	36	36	53	41	2,863	220,698.75	924	24	10	1		1	36	
9[d]	814,15,19	12	12	19	12	1,665	465,750.00	301	8	4				12	
10	816,17,18	28	28	38	29	1,483	250,308.75	521	9	17	2			28	
11	820,21,22,26	8	8	11	8	452	24,044.00	82	4	4				8	
12	823,24,25	22	22	35	24	950	19,962.00	391	14	8				22	
13	827,28,29,902	5	5	5	5	207	8,796.00	52	5					5	
14	830,31,901	8	8	11	8	186	5,413.50	88	8					8	
Totals		148	148	207	157	13,514	1,669,226.75	3,585	92	51	3	1	1	148	

a Number of heads found to have a decodeable coded wire tag.

b Number of adipose finclips observed in the inspected harvest.

c Released at: NL = Nancy Lake; H = Houston; FR = 1988 Fry; 89 = 1989 L. Susitna River smolt; FS = Whittier (smolt releases except FR = 1988 Nancy Lake fry release).

d These strata are adjusted in length to correspond with a change in bag limit from three to five fish.

Table 24. Little Susitna River Burma Road hatchery coho salmon composition point estimate summary by release and survey strata, 16 July through 2 September 1991.

Strata	Dates of Survey	Hatchery Fish[a] NL	SE[b]	H	SE[b]	FR	SE[b]	89	SE[b]	FS	SE[b]	Total	SE[b]
1	716,17,18,22	0		0		0		0		0		0	
2	719,20,21	0		21	20.7	0		44	43.6	0		65	48.2
3	723,24,25,29	0		0		0		0		0		0	
4	726,27,28	21	--[c]	0		0		0		0		21	--[c]
5	730,31,801,05	0		0		0		0		0		0	
6	802,03,04	109	53.3	36	26	0		0		0		145	59.4
7[d]	806,07,08,12,13	650	211.5	247	116.7	0		0		0		897	241.5
8	809,10,11	658	161.3	271	92.1	626	625.5	0		19	18.5	1,574	652.7
9[d]	814,15,19	479	239.6	239	142.5	0		0		0		718	278.8
10	816,17,18	236	105.8	441	174.4	1,196	889.3	0		0		1,873	912.4
11	820,21,22,26	207	114.9	205	113.8	0		0		0		412	161.7
12	823,24,25	339	93.3	192	68.3	0		0		0		531	115.6
13	827,28,29,902	136	80.8	0		0		0		0		136	80.8
14	830,31,901	159	76.3	0		0		0		0		159	76.3
Totals		2,994	420.1	1,652	302.5	1,822	1,087.2	44	43.6	19	18.5	6,531	1,205.1

[a] Released at: NL = Nancy Lake; H = Houston; FR = 1988 Fry; 89 = 1989 L. Susitna River smolt; FS = Whittier (smolt releases except FR = 1988 Nancy Lake fry release).

[b] Standard error (bias-corrected).

[c] SE was not possible to estimate due to only one tag recovery during this stratum.

[d] These strata are adjusted in length to correspond with a change in bag limit from three to five fish.

Only 3 of 113 coho salmon examined from the Miller's Landing and Reach sport fishery had a missing adipose fin (Table 25). Two heads were recovered from the three fish and sent to the FRED Division CWT lab for tag decoding, to estimate the hatchery contribution to the Miller's Landing and Miller's Reach harvest. The surveys were grouped into 7-day periods to agree with the grouping at Burma Road and at the weir. Both heads recovered during the Miller's Landing and Miller's Reach surveys had decodeable CWT's from the 1990 Nancy Lake smolt release and were recovered during the 20 through 26 August survey period. A hatchery contribution was, therefore, estimated only during that survey period. No CWT's were recovered from the 1990 Houston release at the Miller's Landing or Miller's Reach survey sites. Based on these data, the estimated contribution of hatchery-produced coho salmon from the 1990 Nancy Lake smolt release to the sport harvest in the Little Susitna River through Miller's Landing and Reach during 1991 was 53 fish (SE = 38) (Table 26). This represents 9.4% of the estimated 565 coho salmon harvested through the Miller's Landing and Reach access sites.

Of a total 5,999 (15.3%) coho salmon from the escapement (39,241 fish) past the weir, 204 were observed to have a missing adipose fin (Table 27). Escapement through the weir, the number of coho salmon inspected, and the number of missing adipose fins observed were grouped into 7-day strata to agree with the bag limit change from one to three coho salmon starting on 6 August. The hatchery contribution for each 7-day strata was then estimated separately and summed (with the respective variances) to produce the total estimated hatchery contribution through the weir. Coho salmon at the weir were not killed to recover the CWT. Several tag codes were present in the escapement as indicated by the hatchery contributions to the harvest. Only the two major releases contributing to the hatchery contribution in the Burma Road boat angler sport harvest, smolt releases at Nancy Lake and Houston, were used in estimating the hatchery contribution at the weir. These releases and the number of smolt reported marked were summed for a tagging proportion of 0.1466.

Based on these data, the hatchery contribution to the 39,241 coho salmon passing through the weir was estimated to be 8,375 (SE = 593) fish or about 21.4% of the escapement. The total estimated hatchery contribution to the harvest and the escapement is summarized in Table 28.

The total hatchery contribution to the Little Susitna River, with adjustment to the escapement estimate for the estimated hatchery contribution harvested upstream of the weir, was estimated to be 14,853 (SE = 1,343) coho salmon or 28% of the total estimated return excluding those harvested by unsurveyed anglers.

Stocking and Egg Collection

The 1991 hatchery contribution to the Little Susitna River coho salmon sport fishery was the product of the five hatchery releases listed above. The major hatchery returns were the two 1990 Little Susitna River smolt releases. An estimate of the contribution from the 1988 fry release was also completed.

Table 25. Little Susitna River Miller's Landing and Miller's Reach coho salmon coded wire tag recovery summary by release and survey strata, 9 August through 2 September 1991.

Strata	Heads W/CWT	Dec[a] CWT	Clips[b] Obser.	Heads To Lab	Estimated Harvest	Variance	Number Inspected	Unique Code[c] NL	H	FR	89	FS	Total	Tagging Proportion
809-812	0	0	0	0	74	1,499.06	18						0	NL = 0.1462
813-819	0	0	1	0	184	4,994.06	41						0	H = 0.1476
820-826	2	2	2	2	201	3,972.00	52	2					2	FR = 0.0064
827-902	0	0	0	0	106	2,540.81	2						0	89 = 0.7150
Totals	2	2	3	2	565	12,825.93	113	2					2	

[a] Number of heads found to have a decodeable coded wire tag.

[b] Number of adipose finclips observed in the inspected harvest.

[c] Released at: NL = Nancy Lake; H = Houston; FR = 1988 Fry; 89 = 1989 L. Susitna River smolt; FS = Whittier (smolt releases except FR = 1988 Nancy Lake fry release).

Table 26. Little Susitna River Miller's Landing and Miller's Reach hatchery coho salmon composition point estimate summary by release and 7-day survey period, 16 July through 2 September 1991.

	Hatchery Fish[a]											
Strata	NL	SE[b]	H	SE[b]	FR	SE[b]	89	SE[b]	FS	SE[b]	Total	SE[b]
809-812	0		0		0		0		0		0	
813-819	0		0		0		0		0		0	
820-826	53	38.4	0		0		0		0		53	38.4
827-902	0		0		0		0		0		0	
Totals	53	38.4	0		0		0		0		53	38.4

[a] Released at: NL = Nancy Lake; H = Houston; FR = 1988 Fry; 89 = 1989 L. Susitna River smolt; FS = Whittier (smolt releases except FR = 1988 Nancy Lake fry release).

[b] Standard error (bias-corrected).

Table 27. Little Susitna River weir coho salmon hatchery composition summary data, 1991.

Strata	Escapement Thru Weir	Number Inspected	Clips Observed	Percent Inspected	Percent Hatchery[a]	Wild Fish	Hatchery Fish	SE[b]
725-729	434	75	0	17.3%	0.0%	434	0	
730-805	1,330	283	1	21.3%	2.4%	1,298	32	--[c]
806-812	6,476	952	14	14.7%	10.0%	5,826	650	170.7
813-819	19,943	2,519	66	12.6%	17.9%	16,379	3,564	429.6
820-826	2,577	460	19	17.9%	28.2%	1,851	726	161.6
827-902	2,881	429	20	14.9%	31.8%	1,965	916	198.7
903-909	4,473	871	56	19.5%	43.9%	2,511	1,962	251.5
910-916	1,127	410	28	36.4%	46.6%	602	525	94.4
Totals	39,241	5,999	204	15.3%	21.4%	30,866	8,375	592.9

[a] Assumes all clips observed have a decodeable tag from the combined Nancy Lake-Houston 1990 smolt release (pr = 0.1466).

[b] Standard error of hatchery contribution estimate.

[c] SE was not possible to estimate due to there only being one hatchery mark observed in the escapement during this stratum.

Table 28. Contribution of hatchery-origin coho salmon to the sport harvest and escapement past the Little Susitna River weir in 1991.

	Total		Hatchery		
Location	Number	SE	Number	SE	Percent
Fishery Harvest					
Burma Road	13,514	1,292.0	6,531	1,205.1	48.3
Miller's	565	113.0	53	38.4	9.4
Total	14,079	1,296.9	6,584	1,205.7	46.8
Weir Count	39,241	--[a]	8,375	592.9	21.4

[a] Measured without error.

The 1989 smolt release and the Whittier smolt release were considered anomalies.

Coho salmon fry of Little Susitna brood were stocked in the Little Susitna River from 1982 through 1990. The 1988 release totaled approximately 3,383,000 fry (Appendix D1) of which approximately 1,883,000 were released in Nancy Lake. Of this release, approximately 12,000 (0.64%) were marked with a clipped adipose fin and a CWT. Only adults from this Nancy Lake release were, therefore, detectable in the 1991 return. Age-2.1 adults from the 1988 Nancy Lake fry release were detected in stratum 8 (9, 10, and 11 August) and in stratum 10 (16, 17, and 18 August). The total hatchery contribution to the Burma Road sport fishery from this fry release was estimated at 1,822 (SE = 1,087) fish (27.9%) or 0.01% of the fry when stocked in 1988. In addition, one tag from this release was recovered from the 1991 Nancy Lake egg take (Table 29). The total number of salmon returning to the egg take site was not enumerated. However, based on examination of 1,187 coho salmon during egg take operations, the hatchery contribution from this fry release was estimated to comprise 38% of the fish returning to the egg-take site (Table 30).

Coho salmon smolt of Little Susitna brood have been released into the Little Susitna River drainage since 1985 (Appendix D2). Adult return from the 1990 releases at Houston and Nancy Lake provided 71.1% of the hatchery contribution in the Burma Road sport fishery. The hatchery contributions to the Burma Road boat angler sport harvest from the Nancy Lake and Houston smolt releases were not significantly different at $\alpha = 0.05$ ($\chi^2 = 2.47$ with 1 degree of freedom) and were approximately 1.5% of the smolt released at each site. Fish from the Nancy Lake 1990 smolt release comprised an estimated 58.4% of the return to the egg take site. No fish from the Houston 1990 smolt release were observed at the egg-take site.

The 1991 brood of coho salmon eggs was collected from sexually mature fish in Nancy Lake near the mouth of Lilly Creek. At an estimated 76% egg to smolt survival in the hatchery, approximately 600,000 smolt are expected to result from the 1991 egg take. Approximately 300,000 smolt will be released into the Little Susitna River in 1993. The remainder will be utilized in other hatchery programs. A minimum of 30,000 smolt (10%) will be tagged prior to release. The results of this smolt stocking will be reported after the adult return in 1994.

Computerized data files used to generate these analyses are listed in Appendix F.

DISCUSSION

The 1991 coho salmon sport fishing season (mid-July through early September) was the first season in which the Little Susitna River was managed with a coho salmon management plan. This plan requires the escapement of a minimum of 7,500 nonhatchery coho salmon to the mainstem river upstream of the Parks Highway bridge. To provide for this escapement, the bag and possession limit was reduced from three to one coho salmon until 6 August. The plan also provides for the maximum harvest of hatchery stocks by allowing the Palmer, Alaska Sport Fish area management biologist to increase the bag and possession

Table 29. Little Susitna River, Nancy Lake coho salmon egg collection coded wire tag recovery summary, 1991.

Egg take Dates	Heads W/CWT	Dec[a] CWT	Clips[b] Obser.	Heads To Lab	Number Inspected	Unique Code[c] NL	H	FR	89	FS	Total	Tagging Proportion
Sep. 23	15	15	15	15	163	14			1		15	NL = 0.1462
Sep. 25	8	8	9	9	110	8					8	H = 0.1476
Sep. 27	14	14	14	14	117	13		1			14	FR = 0.0064
Oct. 01	0	0	86	0	797						0	89 = 0.7150
Totals	37	37	124	38	1,187	35		1	1		37	

[a] Number of heads found to have a decodeable coded wire tag.

[b] Number of adipose finclips observed.

[c] Released at: NL = Nancy Lake; H = Houston; FR = 1988 Fry; 89 = 1989 L. Susitna River smolt; FS = Whittier (smolt releases except FR = 1988 Nancy Lake fry release).

Table 30. Little Susitna River, Nancy Lake coho salmon egg collection hatchery stock composition estimate summary by release, 1991.

Location of Release	Hatchery Fish[a]	SE	Percent of Total
Nancy Lake	781	74.5	58.4
Houston	0		0.0
1988 Fry	509	508.7	38.1
1989 Smolt	46	45.3	3.5
Total	1,337	516.1	100.0

[a] Data from Table 29 pooled.

limit from three to five coho salmon in selected reaches of the river once the escapement of 7,500 nonhatchery fish is assured. Regulation (ADF&G 1991) also prohibits the catch-and-release of coho salmon once a limit of salmon is harvested. Previous researchers (Bartlett and Vincent-Lang 1989, Bartlett and Sonnichsen 1990, Bartlett and Bingham 1991) observed a separation in the proportional timing of hatchery and nonhatchery stocks with the majority of the hatchery stock entering the river later in the season. The lower bag and possession limit until 6 August is an effort to preserve the earlier timing of wild stock.

Creel Statistics

The objective of estimating the seasonal effort, harvest, and catch for the boat angler coho salmon fishery (Objective 1) was achieved by conducting creel surveys of boat anglers at three of the major exit points of the fishery: Burma Road boat landing, Miller's Landing, and Miller's Reach. Estimated boat angler-hours of effort (36,411 ± 5,766 angler-hours) in 1991 were not significantly different from the 29,366 ± 6,202 angler-hours estimated by Bartlett and Bingham (1991) in 1990. Precision objectives of ± 15% for the 1991 effort upstream and downstream of the weir were, however, not met. Precision estimates of ± 16% (Table 1) for the estimated effort downstream of the weir approximated the desired level, but the relative precision (± 57%) upstream of the weir by boat anglers exiting the fishery through Burma Road was large due to small numbers of interviews from anglers fishing upstream. The relative precision of the estimated effort of boat anglers exiting through Miller's Landing and Miller's Reach (Table 12) also exceeded the objective level at ± 31% for the same reason.

The estimated harvest by boat anglers exiting the fishery through the Burma Road landing (Table 2) in 1991 (13,514 ± 2,532 coho salmon) increased significantly at $\alpha = 0.05$ from the 1990 estimate of 6,236 ± 1,578 coho salmon of Bartlett and Bingham (1991). The estimated 1991 catch of 17,580 coho salmon increased by 10,251 from the 1990 estimate. Precision estimates of Objective 1 (± 25%) were met for harvest (± 19%) and catch (± 20%) estimates downstream of the weir but were not (± 34% and ± 42%, respectively) met upstream of the weir. The large relative precision around the upstream estimates also stems from the small number of interviews from anglers who fish these waters.

On site observations by ADF&G fisheries staff suggest that relatively few anglers who access the fishery through the Burma Road landing fish upstream of the weir. Personal communications to ADF&G fisheries staff by anglers on the river suggest that, with exception of a few guides who were camped approximately 2 km upstream of the weir, boat anglers were reluctant to fish upstream of the weir because: (1) there was an abundance of ocean-fresh fish downstream of the weir, (2) during the peak of the coho salmon migration, the river was more difficult and hazardous to navigate upstream of the weir due to low water levels, and (3) after 14 August, the five fish bag and possession limit applied only downstream of the weir. Although nonmotorized users (rafters and canoeists) are no longer distinguished from other boat anglers exiting the fishery through Burma Road during the creel survey, much of the effort, harvest, and catch upstream of the weir through Burma Road can be attributed to this group.

The estimated harvest by boat anglers exiting the fishery through the Miller's Landing and Miller's Reach access sites (Table 8) in 1991 of 565 ± 222 coho salmon was not significantly different at $\alpha = 0.05$ from the 1990 estimate of Bartlett and Bingham (1991). The estimated 1991 catch of 664 ± 267 coho salmon was also similar to the 1990 estimate. Objective 1 precision levels around the estimates of harvest and catch of coho salmon through Miller's Landing and Miller's Reach also were not met due to the small numbers of anglers interviewed.

The mean catch rates (Objective 2) of boat anglers exiting the sport fishery through the Burma Road landing were estimated for inseason management of the sport fishery (Table 3). The catch rates by 7-day strata, with exception of the high rate from 30 July through 5 August, followed the seasonal trend as expected and estimated by Bartlett and Bingham in 1990. The high mean catch rate from 30 July through 5 August is possibly the result of the one fish bag limit during the period of peak coho salmon abundance in the intertidal reach of the river (from saltwater to about rkm 32). During this period, it was reported by two well-known fishing guides to be common for some (guides) to catch and release in excess of 50 coho salmon per day before keeping (harvesting) the bag limit of one fish (J. Booth, fishing guide, personal communication).

The overall catch rate per hour of coho salmon at Miller's Landing and Miller's Reach (0.227; Table 14) was not significantly different at $\alpha = 0.05$ from that estimated (0.714) by Bartlett and Bingham (1991) in 1990. These data suggest that fishing productivity through the Miller's Landing and Miller's Reach access sites in 1991 was similar to 1990. Concerns regarding the coho salmon fishery through the Miller's Landing and Miller's Reach access sites communicated to the project leader by Houston area residents during the 1991 fishing season were: (1) coho salmon were late in arriving at the confluence of Nancy Lake Creek and the Little Susitna River, (2) coho salmon were in relatively poor condition (approaching sexual maturity) when they did arrive, and (3) they were very slow to bite (difficult to catch). Figure 2 plots the mean of the estimated mean CPUEs for 1987-1989 (Bartlett and Conrad 1988, Bartlett and Vincent-Lang 1989, Bartlett and Sonnichsen 1990) to the CPUE for 1991. The 1990 CPUE (Bartlett and Bingham 1991) was estimated in two noncomparable strata and can not be included. The 1991 catch rate may be lower than the 1987-1989 mean until 19 August when it approximated the mean for one 7-day strata before declining. These data suggest that coho salmon may have been late in arriving and were difficult to catch as reported, but overall, the coho salmon sport fishery was not much different from that experienced in 1990.

A comparison of the catch rates between the guided and the unguided components of the sport fishery exiting through Burma Road was achieved (Objective 2). The summary of mean catch rates in Table 8 suggests that the professional guides who fish coho salmon on the Little Susitna River are more efficient when compared (nonsignificantly) to the average unguided angler. These data give some credibility to the claims of the guides who reported catching and releasing over 50 coho salmon per fishing day during the 30 July through 5 August period.

Although the overall estimated effort in 1991 was not significantly different from the 1990 estimate, inspection of the effort summary for boat anglers

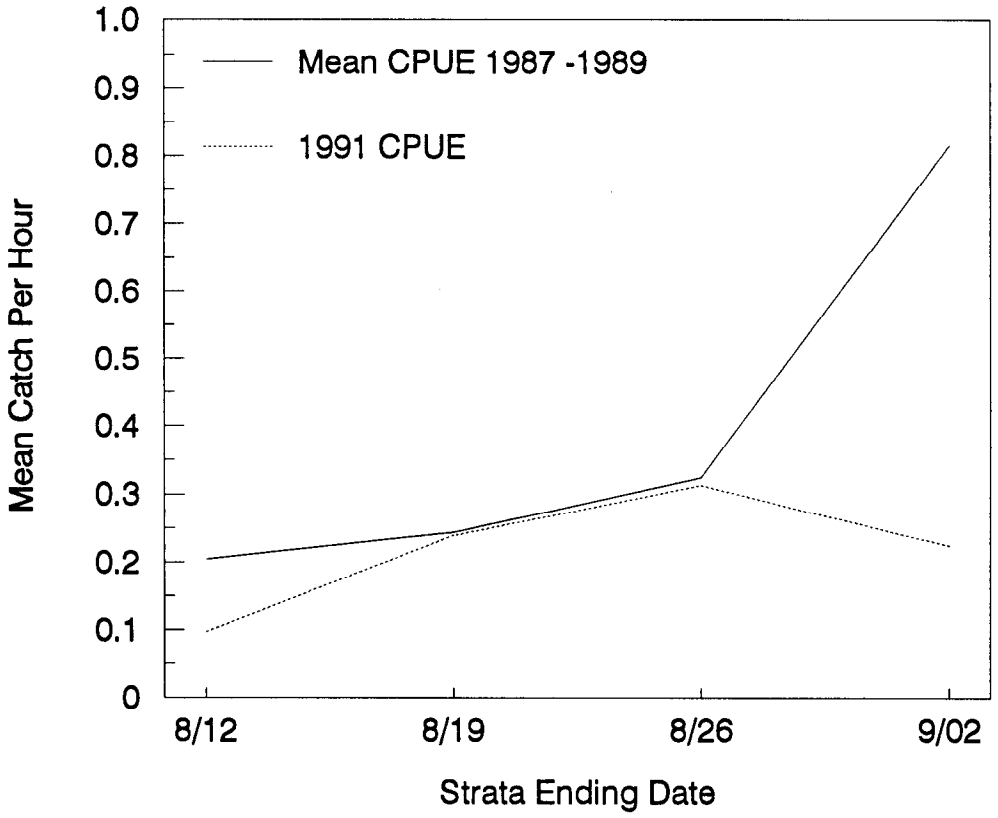

Figure 2. The mean CPUE in angler-hours for 1991 and 1987-1989 by boat anglers exiting the coho salmon sport fishery through the Miller's Landing and Miller's Reach access sites.

fishing downstream of the weir in Table 4 suggests that the reduction in the bag limit to one coho salmon had a negative impact on Burma Road boat angler effort during the 30 July through 5 August period. Coho salmon are normally (and were) plentiful during this period (Bartlett and Vincent-Lang 1989, Bartlett and Sonnichsen 1990, Bartlett and Bingham 1991) and local weather conditions were conducive to a pleasant sport fishing experience. The relatively low effort during the 30 July through 5 August period contrasted with the relatively high effort recorded during the 6 through 13 August period when the bag limit was three coho salmon and may be attributed largely to the one fish bag limit.

Studies by Vincent-Lang et al. (*In prep*) show that the mortality of hooked and released coho salmon in the intertidal waters of the Little Susitna River is as high as 69%. Applying this percent mortality to the estimated number of coho salmon released by boat anglers alone downstream of the weir (Table 5) suggests a possible loss (dead and unharvested) of 1,347 coho salmon (35% of the catch) during the two 7-day strata, one fish bag limit period from 23 July through 5 August. Applying the same argument to the data in Table 3 (page 30) of Bartlett and Bingham (1991) for the same relative period suggests that 18% of the 1990 catch was possibly lost under a three fish bag limit. These data suggest that additional (over that experienced in 1990) coho salmon are perhaps being lost to catch and release mortality. Unsurveyed shore anglers and boat anglers exiting the sport fishery through the Port of Anchorage would add considerably to these mortality estimates.

The mortality caused by anglers on boats accessing the fishery through the Port of Anchorage could potentially be even higher than that by an equal number of anglers accessing the fishery through Burma Road. This is because the Port of Anchorage boats tend to be larger craft capable of safely crossing Knik Arm, but once up the Little Susitna River are prevented from leaving until the next high tide. Many, therefore, stay overnight or even several days on the river waiting for a tide high enough to leave the river mouth. These anglers "held captive" by the tide are regulated by bag and possession limits, but have been observed by ADF&G fisheries staff to spend their time catching and releasing coho salmon while waiting for the high tide. The last year a creel survey was conducted at the Port of Anchorage was during 1988 (Bartlett and Vincent-Lang 1989) in which only 3.2% of the coho salmon estimated caught were reported released. This estimate, however, may be low considering the observations made during the 1989, 1990, and 1991 seasons.

The hook and release mortality of coho salmon is lowered to approximately 12% once fish have acclimated to fresh water and their scales are set tight (Vincent-Lang et al. *In prep*). This physiological change has taken place by the time the fish reach the weir at rkm 52. The mortality of the released portions of the catch upstream of the weir (Table 6) and through the Miller's Landing and Miller's Reach access sites (Table 16) of 4.3% and 1.8%, respectively are therefore relatively small.

Hook and release mortality of coho salmon is largely associated with the use of bait (Vincent-Lang et al. *In prep*). In 1989, 82% of boat anglers used bait and another 14% used some combination of bait and lures (Bartlett and Sonnichsen 1990). The gear type was not included in the 1991 creel survey but

there are no reasons to believe the percent of anglers using bait in the turbid waters of the intertidal reach changed much during the 1991 sport fishery.

The rationale used by Bartlett and Vincent-Lang (1990) to develop the management plan was to "slow down or reduce the harvest potential during the early stages of the sport fishery when naturally-produced fish are prevalent" (page 11). In view of the mortality associated with the prevailing sport fishing practice of catching and releasing as many coho salmon as desired before harvesting a final fish during periods of abundance, perhaps a means to reduce the catch potential until 6 August without reducing opportunity should be re-investigated. This may involve restricting the use of bait downstream of the weir until the escapement goal is achieved.

A total of 52,332 coho salmon were accounted for in the Little Susitna River during 1991. This inriver return is threefold the average since 1978 (Bartlett and Vincent-Lang 1990). The actual inriver return is somewhat greater than this due to fishing effort by unsurveyed shore anglers and anglers who access the sport fishery through the Port of Anchorage. This estimate is based on an estimated escapement of 38,249 coho salmon above the weir, an estimated sport harvest of 992 coho salmon upstream of the weir, and an estimated sport harvest of 13,091 coho salmon downstream of the weir. Based on a total estimated sport harvest of 14,079 coho salmon, this represents a minimum inriver exploitation rate by the sport fishery of about 27%. It is not possible to estimate the total return or exploitation of Little Susitna River stock as an unknown number of coho salmon are also harvested in the mixed-stock commercial fisheries of upper Cook Inlet.

Escapement Statistics

The 1991 escapement of coho salmon through the weir (Objective 5) was the highest recorded in the history of weir placement on the Little Susitna River (Bentz 1987, Bartlett and Conrad 1988, Bartlett and Vincent-Lang 1989, Bartlett and Sonnichsen 1990, Bartlett and Bingham 1991). The mid-point (50%) of the cumulative escapement was 3 days later than that observed by Bartlett and Bingham in 1990 (Figure 3) suggesting that coho salmon run timing in the Little Susitna River is reasonably predictable for inseason management.

The index of aerial escapement (Objective 6) was achieved under excellent flying, viewing, and water clarity conditions. The total number of coho salmon counted during the aerial flight was 5,250 fish. This represents approximately 18% of the potentially available 29,927 coho salmon (escapement adjusted for upstream harvest and Nancy Lake hatchery stock) in the index area. The probable cause for the low proportion of spawning salmon observed in the index areas is the diversity of the coho salmon spawning habitat in the Little Susitna River upstream of the weir. The index areas are in the mainstem river from about rkm 99 to rkm 168 and there are many small tributaries upstream of the weir, in addition to Nancy Lake Creek, that support spawning coho salmon. Given the expense of one aerial survey of the index areas (currently approximately $2,500) and the number of years (data points) that would be required to fully compare the index escapement count to the estimated weir escapement, estimating the total historical escapements from historical index counts using current data is probably not cost effective.

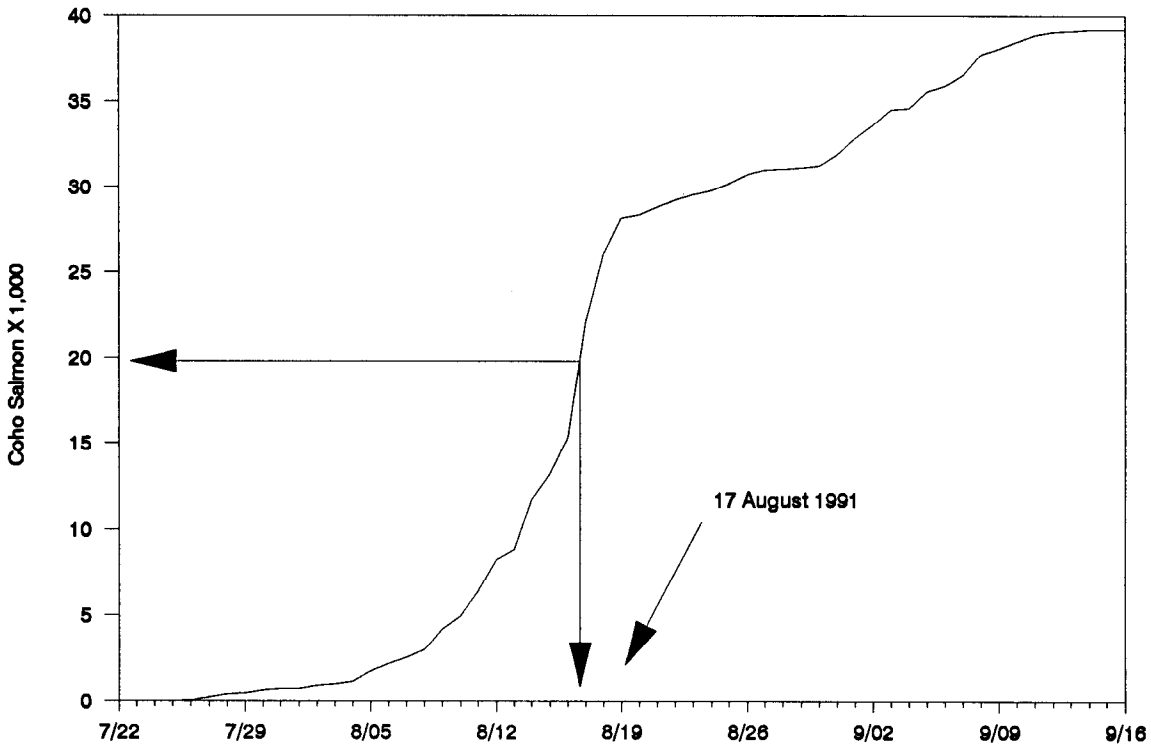

Figure 3. Cumulative escapement of coho salmon through the Little Susitna River weir (rkm 52) in 1991 with the mid-point (50%) noted.

Size, Sex, and Age Compositions

Estimates of age composition (Objective 3) were obtained from samples collected from the harvest and in the escapement at the weir. Hatchery coho salmon from smolt releases are almost exclusively age 1.1 while those from fry releases and nonhatchery stock may be 1.1, 2.1, or occasionally 3.1. The estimated proportion (37% ± 7%) of age-1.1 coho salmon in the escapement through the weir (Table 18) exceeded at $\alpha = 0.05$ the estimated percent hatchery contribution (21% ± 3%) in the escapement (Table 27), suggesting a substantial portion of the nonhatchery and or hatchery-fry release stock smolted in the first year and returned as 1.1 adults. This observation is not uncommon for Little Susitna River stocks and has been observed by other researchers in past years (Bartlett and Vincent-Lang 1989, Bartlett and Sonnichsen 1990, Bartlett and Bingham 1991). The estimated proportion (80.3%) of 1.1 fish in the Burma Road harvest (Table 12) is over twofold the estimated proportion of 1.1 fish in the escapement. Similar observations have also been recorded by previous researchers (Bartlett and Vincent-Lang 1989, Bartlett and Sonnichsen 1990, Bartlett and Bingham 1991).

The reason behind this observation is elusive but may have origins in the length of time the hatchery stocks sojourn in the intertidal reach of the river before migrating upstream. That is, for some unexplained reason, the hatchery stocks may become behaviorally stalled for a time in the lower river and are more susceptible to harvest by virtue of exposure to the fishery, while the nonhatchery stock migrates steadily upstream. The observed proportional timing between hatchery and nonhatchery stocks through the weir (Figure 4) may be evidence of this speculative difference in behavior.

As hatchery coho salmon from smolt stockings are almost exclusively age-1.1 fish, a two-tailed *t*-test was used to compare the mean length by sex of age-1.1 coho salmon sampled from the 1991 harvest and escapement to those sampled from the 1986 harvest and escapement. No significant differences ($\alpha = 0.05$) were found between the mean lengths of these samples so the 1991 age-1.1 samples were compared by sex to the mean lengths of combined ages collected from the Little Susitna River sport harvest in 1983 (Bentz 1984). No significant difference ($\alpha = 0.05$) was found between any of these samples, suggesting that the mean length by sex of coho salmon in the Little Susitna River has not changed significantly with the introduction of hatchery stocks.

Bentz (1987) estimated temporal trends in the sex ratio of Little Susitna River coho salmon in which females were the dominant sex during the first stratum of the 1986 Burma Road harvest and males were dominant during the entire escapement. Temporal trends in the sex ratio of coho salmon in the Burma Road harvest and in the escapement were also published by Bartlett and Bingham (1991) in 1990. In these three samples, males were found to be dominant during the first several strata. Temporal trends (nonsignificant) in 1991 were also observed to favor males during the first few strata (Table 31) in two samples collected from the Burma Road harvest and in one sample collected from the escapement at the weir. These 3 years of data suggest that dominance in the sex ratio by one sex during the early strata of the harvest is probably not predictable from year to year for possible inseason management purposes as suggested by Bentz (1983, 1984). Several more years of data are needed before consistent temporal trends in sex ratios would be evident. Also, the belief that anglers tend to cull their catch for females early in

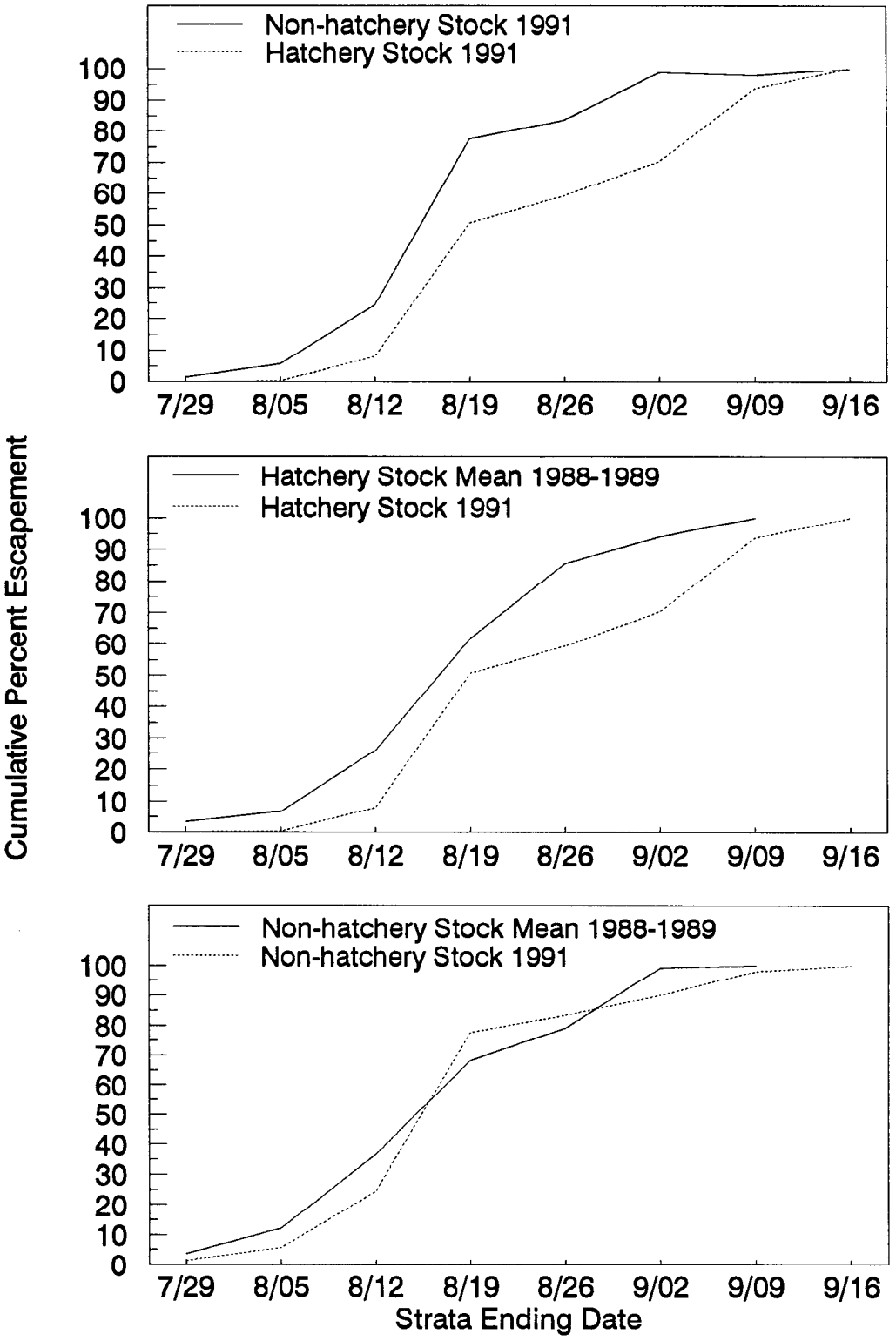

Figure 4. Proportion of timing of estimated 1991 and 1988-1989 hatchery and nonhatchery coho salmon stocks through the Little Susitna River weir (rkm 52).

Table 31. Summary of the sex ratios observed in samples from the Burma Road harvest and from the escapement at the weir (rkm 52) in 1991.

	Harvest[a]			Harvest[b]			Escapement		
Strata	Females	Males	Ratio	Females	Males	Ratio	Females	Males	Ratio
716-722	31	43	0.7:1	50	70	0.7:1			
723-729	26	46	0.6:1	66	116	0.6:1	9	14	0.6:1
730-805	29	25	1.2:1	107	106	1.0:1	31	25	1.2:1
806-813[c]	32	38	0.8:1	420	459	0.9:1	33	52	0.6:1
814-819[c]	28	27	1.0:1	286	341	0.8:1	20	37	0.5:1
820-826	37	16	2.3:1	230	112	2.1:1	25	35	0.7:1
827-902	22	19	1.2:1	63	45	1.4:1	24	23	1.0:1
903-909							32	39	0.8:1
910-916							25	28	0.9:1
Total	205	214	1.0:1	1,222	1,249	1.0:1	199	253	0.8:1

[a] From age, length and sex composition sample.

[b] From hatchery mark inspection sample.

[c] Strata adjusted to agree with a change in bag limit.

the fishery as a source of bait eggs would be dispelled by a consistent dominance of males early in the harvest.

Hatchery Contributions

Hatchery contributions (Objective 4) to the harvest and to the escapement were obtained through inspecting the harvest and a sample of the escapement for a hatchery mark (clipped adipose fin). The head from fish in the harvest having the mark was collected and sent to the tag lab for dissection and decoding of the tag. Fish having the mark in the escapement sample were not killed for decoding of the tag. Instead, the main smolt releases (Nancy Lake and Houston) were summed and the tagging proportion of the total used to estimate the hatchery contribution to the escapement. The hatchery estimate to the escapement therefore, is a minimal estimate because it ignores the contribution from the 1988 fry release and others that were decoded from the harvest (see Table 24). If a better estimate is desired during years of multiple release returns, coho salmon from the sample at the weir having a hatchery mark should be killed for decoding of the CWT. During this season, 204 hatchery coho salmon would have been killed at the weir (and donated to charity) for decoding of the tag (Table 27). The next hatchery return where killing coho salmon may be necessary to obtain an estimate at the weir which includes the majority of the tag codes released will be in 1993 when adults from a 1990 fry release are expected to return (Appendix D1). This should be the only year killing hatchery marked fish at the weir may be necessary because under current stocking policy, future releases in the Little Susitna River drainage will be restricted to smolt releases of two tag codes.

The killing of approximately 200 hatchery coho salmon at the weir should not be detrimental to the upstream harvest of hatchery fish in view of the relatively small contribution they have made in recent years to the upstream harvest, or to the availability of hatchery fish for the Nancy Lake egg take in view of the surplus of hatchery fish (approximately 2,500 fish in 1991) in Nancy Lake.

The percent hatchery contribution to the harvest estimated for the 1991 season was not significantly different at $\alpha = 0.05$ from the estimates of 1987 through 1990 (Table 32). The estimated percent hatchery contribution to the harvest again exceeded the hatchery contribution to the escapement by approximately twofold as it did during 1988 and 1989. The 1991 hatchery contribution estimated for the 1991 escapement would be expected to be higher, however, if the contribution of hatchery coho salmon originating from the 1988 fry release (Table 18) were added. As explained above, this was not possible because coho salmon having a missing adipose fin were not killed at the weir for decoding of the tag. The reason why the estimate for the harvest sometimes exceeds that at the weir is elusive but may have origins in the behavior of the hatchery fish in the intertidal reach of the river as discussed above.

The proportional timing of hatchery coho salmon in the 1991 escapement through the weir lagged the timing of the nonhatchery stock (Figure 4) similar to that observed by Bartlett and Vincent-Lang (1989), Bartlett and Sonnichsen (1990), and Bartlett and Bingham (1991). Overall, the proportional timing of the 1991 hatchery and nonhatchery stocks lagged the mean timing for 1988 and 1989, suggesting that the 1991 escapement of coho salmon were a few days later in arriving at the weir than the 1988 and 1989 stocks. Warm water temperatures

Table 32. Contribution of hatchery-origin coho salmon to the estimated sport harvest and escapement past the Little Susitna River weir from 1986 through 1991.

	Total[a]		Hatchery[a]		
Year	Harvest	SE	Harvest	SE	Percent
Harvest:					
1986	5,812	--[b]	107	30.5	1.8
1987	13,202	442.1	3,460	509.7	26.2 ± 7.8
1988	12,759	405.0	6,468	571.9	50.7 ± 9.3
1989	14,150	746.3	10,660	1,275.2	75.0 ± 19.3
1990	8,001	866.8	2,393	478.0	29.9 ± 13.3
1991	14,079	1,297.0	6,584	1,205.7	46.8 ± 18.8
Escapement:					
1986[c]					
1987[d]					
1988	21,438	--[e]	4,764	1,076.3	22.2 ± 9.8
1989	15,855	--[e]	7,191	757.6	45.9 ± 9.4
1990	15,511	--[e]	3,791	449.0	24.4 ± 5.7
1991	39,241	--[e]	8,375	592.9	21.4 ± 3.0

[a] 1986 through 1990 data were taken from Federal Aid annual reports.

[b] Standard error not reported.

[c] No tagged fish reported.

[d] No weir in place.

[e] Measured without error.

in the Little Susitna River delayed the 1990 run timing (Bartlett and Bingham 1991) but no inriver or climatic anomalies were evident in 1991 and the reason for the observed tardiness is unexplained.

The date when the escapement goal of 7,500[6] nonhatchery fish would be available for spawning was predicted by Bartlett and Vincent-Lang (1990) to be "somewhere around" 16 August. The actual date the hatchery goal should be met in practice could be up to several days earlier because of additional fish expected to be made available to the escapement by the one fish bag limit until 6 August. The date the escapement goal was met under the management plan during 1991 was 13 August (Figure 5). The five coho salmon bag limit was made effective by emergency order beginning at 1200 hours on 14 August. These data suggest the management plan is providing for preservation of the early arriving nonhatchery coho stocks as intended. The loss (dead and unharvested) of coho salmon to hook and release mortality prior to the escapement goal being met could, however, have serious consequences during years of less abundance.

The five fish bag and possession limit coincided nicely with the proportionately late timing of the hatchery stocks (Figure 6). During the five fish bag limit, 77.5% of the coho salmon harvested were estimated to be hatchery stock and an estimated 36.1% of the boat anglers fishing downstream of the weir harvested more than three fish. These data suggest the management plan is providing for the harvest of surplus hatchery stock as intended. In addition, approximately 75% (from Table 27) of the nonhatchery stock passed the weir and were available for spawning while the five fish bag limit was in place downstream of the weir. These later run nonhatchery coho salmon, if they spawn later than those from the earlier portion of the run, would tend to preserve the genetic integrity and traditional run timing of the nonhatchery stocks. The five fish bag limit should not be put in place before the escapement goal is met as a result of these later arriving nonhatchery fish if preservation of the early arriving fish run timing and continued separation of hatchery and nonhatchery stocks remain program goals.

Stocking and Egg Collection

Stocking program goals for the Little Susitna River have not been written. Two major benefits, however, have been realized since the first returns of hatchery fish. These are increases in the effort for and the harvest of coho salmon (Bartlett and Vincent-Lang 1990) and an extension of the fishery in the reach of river accessible through the Burma Road access site. Indirect benefits have been centered around public facility improvements and the economic benefits to local businesses. Inriver returns of hatchery stock from smolt stockings have ranged from 1.7% in 1990 to 4.8% in 1991 (Table 33). These returns seem to be sufficient for both sport harvest and the egg take. Future smolt releases to the Little Susitna River have been programmatically capped at 300,000 smolt, which, under current effort and harvest estimates, are enough to sustain the enhancement program.

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[6] A total of 8,000 nonhatchery coho salmon are passed through the weir to meet the escapement goal of 7,500 fish. The additional 500 fish were expected to compensate for the upstream harvest of non-hatchery stocks.

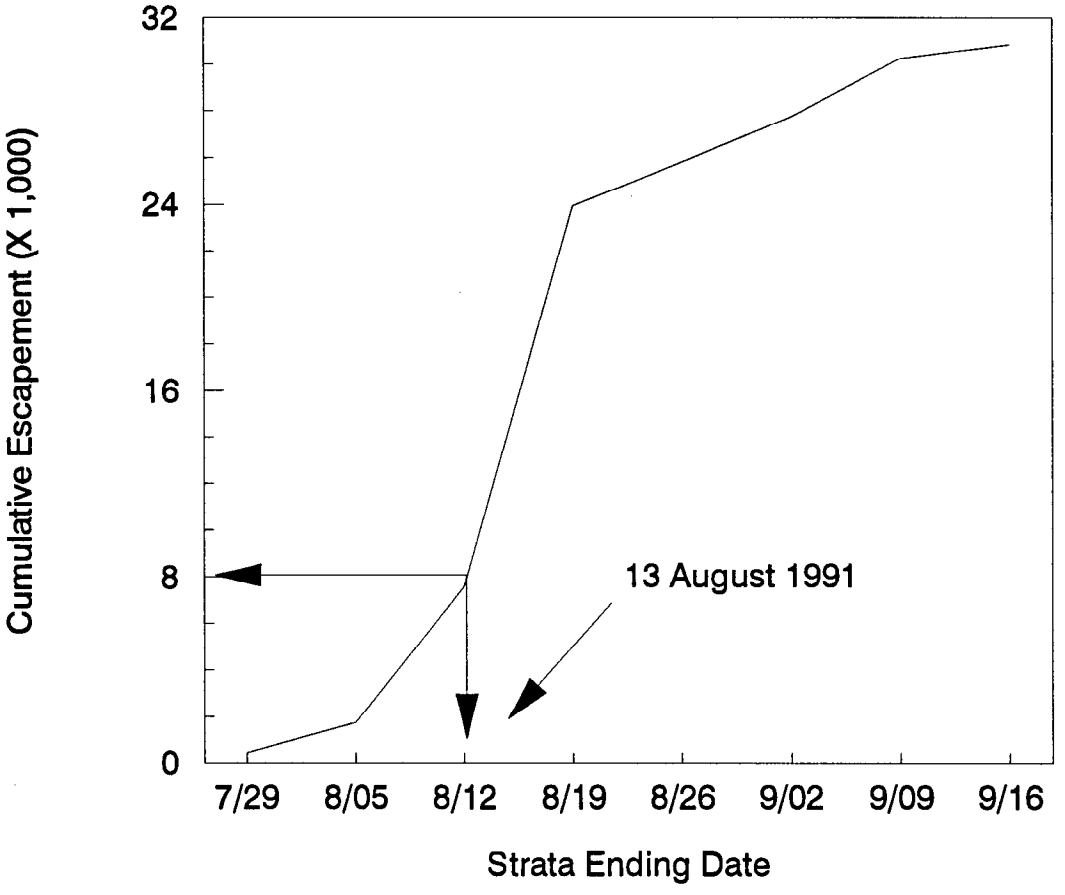

Figure 5. Estimated cumulative escapement of nonhatchery coho salmon through the Little Susitna River weir (rkm 52) in 1991.

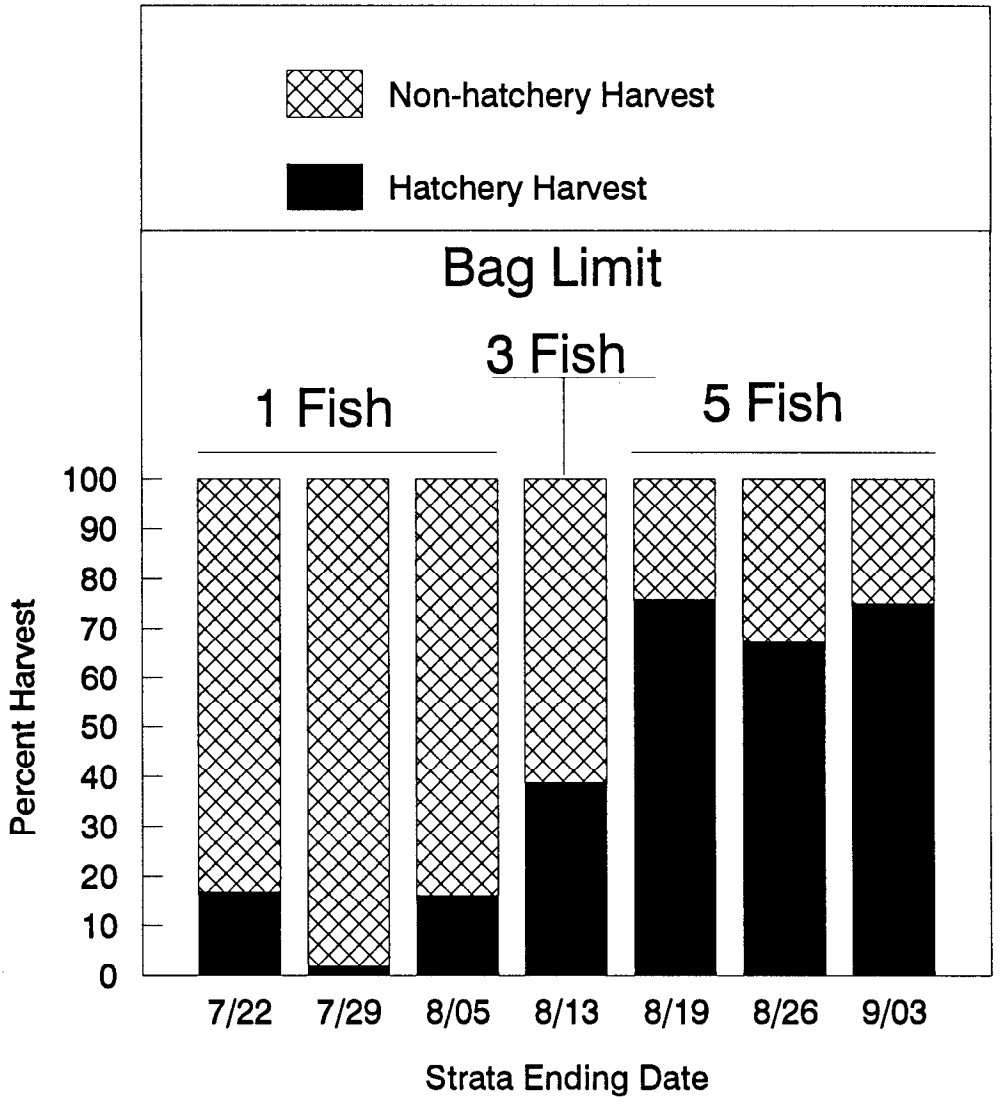

Figure 6. Percent harvest of coho salmon downstream of the Little Susitna River weir (rkm 52) by 7-day strata in 1991.

Table 33. Estimated percent inriver return of hatchery stock coho salmon to the Little Susitna River from smolt releases, 1988-1991.

Return Year	Estimated Return[a]	Smolt Released	Percent Return
1988	11,232	301,167	3.7
1989	17,851	446,016	4.0
1990	6,184	354,897	1.7
1991	14,959	308,356	4.8

[a] Estimated harvest plus escapement of hatchery stocks from Federal Aid Reports.

Hatchery smolt were stocked in the mainstem river at Houston in 1987 and again in 1989 (Appendix D2) in an effort to increase the angler participation in the Houston area. Although the survival of the Houston smolt release appeared to equal the Nancy Lake release, increased angler participation in the immediate vicinity of Houston as a result of release has not been evident. The 1991 return was the first Houston release to be uniquely tagged and it was evident that the return from this release was harvested by anglers accessing the river through the Burma Road landing. Other than contributing to the harvest downstream of the weir, the final destination of the adult return from the Houston release is unknown. They were not recovered from the two Miller's area creel surveys and they were not recovered during the egg collection. Several schools of approximately 200 to 400 each of coho salmon were observed by ADF&G fisheries staff between the confluence of Nancy Lake Creek and Houston as late as the third week in September, but it is unknown if these were composed of returning Houston released smolt. There were no unusual numbers of coho salmon observed during several timely inspections of the Houston release site. The fish, therefore, probably continued upstream to spawn with the nonhatchery stock.

If returning hatchery fish to the Houston area is a stocking goal, a means to imprint the fish to the release site should be investigated. Returning the fish to the vicinity of the release site would not however, change the characteristically late timing of the Little Susitna River hatchery stocks. If increasing sport fishing participation in the immediate vicinity of Houston is a stocking goal, it is probably not realistic because of the late timing of Little Susitna River hatchery stocks. Measurable stocking goals regarding the above discussion have not yet been written.

Recommendations

Based on the data contained in this report and discussion, we recommend the following:

1. Develop a statement of goals for the Little Susitna River detailing the history and expectations of the stocking program, management plan, facility development, and environmental protection efforts in one document. Develop alternatives in the event a program or a portion of a program does not work as planned.

2. In a effort to reduce the number of coho salmon lost to hook and release mortality, give future consideration to returning to a three fish bag and possession limit downstream of the weir coupled with artificial-lure-only requirements through 5 August, annually. Although the one fish bag limit appears to be providing the necessary fish for preservation of the early nonhatchery escapement timing, the percent of coho salmon lost to current hook and release practices may be unacceptable during years of less abundance.

3. Adipose finclipped coho salmon be killed at the weir during the 1993 return and future smolt releases at Houston and Nancy Lake be tagged in equal proportions. Recovery of CWT's should provide a more accurate estimate of the contribution from the respective releases

expected to return. Tagging future releases in equal proportions will eliminate the need to kill coho salmon after 1993 at the weir to recover CWT's.

4. Eliminate the creel survey at the Miller's Landing and Reach access sites for the 1992 season. Declining effort and harvest through these sites during the past several years questions the need for this expensive operation on an annual basis and the Miller's area creel and hatchery contribution data are not used for inseason management purposes. Continue to add the mean 1987-1990 upstream harvest of 500 nonhatchery coho salmon to the escapement goal before liberalizing the harvest to five fish.

5. Promote a terminal harvest of surplus hatchery fish in Nancy Lake immediately after the egg take. These fish are not the best quality but some people would gladly harvest them if they were made aware the fish were so easily available. As it is now, a few hundred ascend Lilly Creek to spawn naturally and the remainder (about 2,500 fish in 1991) die at the creek mouth.

6. Survey the larger boats accessing the fishery through the Port of Anchorage on several randomly selected days from 16 July through 5 August 1992 to estimate the proportion of coho salmon these anglers are releasing during the one fish bag limit. This could be accomplished by the project leader (or designee) on the river. Alternatively, a creel survey could be conducted at the Port of Anchorage.

7. Discontinue the aerial survey unless the weir is submerged or damaged for a period of time long enough to prevent a census of the desired escapement goal of nonhatchery fish.

8. Discontinue estimating effort, harvest, and catch statistics by guided and unguided angler categories. This information is analyzed postseason and not used for inseason management of the fishery. Past research indicates that guided anglers are consistently more efficient than unguided anglers. The benefit of annually reconfirming this fact does not justify the expense of collecting and analyzing the data.

9. To equal the probability of survival and reduce rearing and tagging biases within the release lots, rear the smolt in equal portions of 150,000 smolt per raceway. This will eliminate such past practice as tagging smolt of unequal weights from different raceways with the same tag code and holding Little Susitna River tagged smolt in one section of the raceway while a portion of the untagged smolt are reared for release in another system in the same raceway.

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APPENDIX A

Appendix A1. Little Susitna River, Burma Road landing coho salmon creel survey strata definitions and pertinent sampling information, 1991.

Stratum	Days Available for Sampling	Number of Days Sampled	Number of Periods Per Day
1. 16-18, and 22 July (weekdays)	4	2	5
2. 19-21 July (weekends)	3	3	5
3. 23-25, and 29 July (weekdays)	4	2	5
4. 26-28 July (weekends)	3	3	5
5. 30 and 31 July, 1 and 5 August (weekdays)	4	2	5
6. 2-4 August (weekends)	3	3	5
7. 6-8, and 12 August (weekdays)	4	2	5
8. 9-11 August (weekends)	3	3	5
9. 13-15, and 19 August (weekdays)	4	2	5
10. 16-18 August (weekends)	3	3	5
11. 20-22, and 26 August (weekdays)	4	2	4
12. 23-25 August (weekends)	3	3	4
13. 27-29 August, and 2 September (weekdays)	4	2	3
14. 30 and 31 August, and 1 September (weekends)	3	3	3

Appendix A2. Little Susitna River Burma Road landing coho salmon creel survey daily sample periods, 1991.

Fishery	Time of Season	Sample Period	Time of Day
Boat, coho salmon	16 July to	A	0400-0759
	19 August	B	0800-1159
		C	1200-1559
		D	1600-1959
		E	2000-2359
Boat, coho salmon	20 August to	A	0500-0859
	26 August	B	0900-1259
		C	1300-1659
		D	1700-2059
Boat, coho salmon	27 August to	A	0700-1059
	2 September	B	1100-1459
		C	1500-1859

Appendix A3. Little Susitna River, Miller's Landing and Miller's Reach coho salmon creel survey strata definitions and pertinent sampling information, 1991.

Stratum	Days Available for Sampling	Number of Days Sampled	Number of Periods Per Day
Miller's Landing:			
15. 9-11 August (weekends)	3	2	5
16. 12 August (WD)	1	1	5
17. 13-15, and 19 August (weekdays)	4	2	5
18. 16-18 August (weekends)	3	2	5
19. 20-22, and 26 August (weekdays)	4	2	4
20. 23-25 August (weekends)	3	2	4
21. 27-29 August, and 2 September (weekdays)	4	2	3
22. 30 and 31 August, and 1 September (weekends)	3	2	3
Miller's Reach:			
23. 9-11 August (weekends)	3	2	5
24. 12 August (WD)	1	1	5
25. 13-15, and 19 August (weekdays)	4	2	5
26. 16-18 August (weekends)	3	2	5
27. 20-22, and 26 August (weekdays)	4	2	4
28. 23-25 August (weekends)	3	2	4
29. 27-29 August, and 2 September (weekdays)	4	2	3
30. 30 and 31 August, and 1 September (weekends)	3	2	3

Appendix A4. Estimation equations for catch per unit of effort as an index of abundance for the creel survey conducted during 1991 on the coho salmon sport fishery in the Little Susitna River.

Estimates of catch per unit of effort (CPUE) as an index of abundance for the 1991 Little Susitna River coho salmon sport fishery were obtained by first obtaining the CPUE for each angler:

$$CPUE_{tijk} = \frac{c_{tijk}}{e_{tijk}} ; \qquad (A4.1)$$

where: c_{tijk} and e_{tijk} equal the catch and effort of each interviewed completed-trip angler, respectively (note that the subscript t refers to 7-day periods, i.e., ignoring the type of day level of stratification).

The mean CPUE for each section and 7-day period of the fishery were then calculated over all anglers interviewed within each section and time period:

$$\overline{CPUE_t} = \frac{\sum_{i=1}^{d_t} \sum_{j=1}^{p_{ti}} \sum_{k=1}^{m_{tij}} CPUE_{tijk}}{m} ; \qquad (A4.2)$$

where: m_{tij} equals the number of anglers interviewed within each period, p_{ti} equals the number of periods sampled within each day, d_t equals the number of days sampled within each 7-day period and section, and m equals the total number of anglers interviewed within each period and section, obtained as;

$$m = \sum_{i=1}^{d_t} \sum_{j=1}^{p_{ti}} m_{tij} . \qquad (A4.3)$$

The variances of the period and section estimates of CPUE were obtained by the following equation:

$$\hat{V}[\overline{CPUE_t}] = \frac{\sum_{i=1}^{d_t} \sum_{j=1}^{p_{ti}} \sum_{k=1}^{m_{tij}} (CPUE_{tijk} - \overline{CPUE_t})^2}{m\,(m-1)} . \qquad (A4.4)$$

Appendix A5. Estimation equations for the distribution of catches and harvests for the creel survey conducted during 1991 on the coho salmon sport fishery in the Little Susitna River.

The distribution of catches and harvest as described in the body of this report were estimated as described below for the 1991 survey. We first coded the data to correct for possible biases due to changing amounts of angler effort (in terms of angler-trips). From Sukhatme et al. (1984: equation 8.58; page 327):

$$y_{khijo} = \begin{cases} M_{hij}/\bar{M}^{*}_{hi} & \text{if harvest made by interviewed angler } o \text{ during sample } j \text{ on day } i \text{ within stratum } h \text{ caught k or more coho salmon (or zero coho salmon if k = 0);} \\ 0 & \text{otherwise;} \end{cases} \quad \text{(A5.1)}$$

where: M_{hij} equals the number of angler-trips for each sample (equal to the number of exiting anglers within each sample);

$\bar{M}^{*}_{hi}$ = the "restricted" mean of the possible number of angler-trips for each day estimated as the mean of the number of angler-trips (restricted to periods in which one or more angler-trips are estimated):

$$= \frac{\sum_{j=1}^{p^{*}_{hi}} M^{*}_{hij}}{p^{*}_{hi}}; \quad \text{(A5.2)}$$

M^{*}_{hij} equals number of exiting anglers counted during each sample, but restricted to only counts that are greater than zero;

p^{*}_{hi} equals the number of periods during each day with at least one angler-trip estimated; and all other terms are as defined above.

-continued-

The angler met the criterion if his or her harvest $h_{hijo} \geq k$ where $k = 1$ to kmax or $h_{hijo} = 0$ for $k = 0$; otherwise $y_{khijo} = 0$. The data were recoded for each iteration from 0 to kmax. After coding, the average fraction and its variance were found for each stratum (and for each type of trip: 1-day, 2-day, etc.):

$\equiv$
y_{kh} = estimated proportion of angler-trips in each stratum that harvest 0 or at least k coho salmon;

$$= \frac{d_h^* = \sum_{i=1} y_{khi}}{d_h^*}; \qquad \text{(A5.3)}$$

where: d_h^* equals the restricted number of days sampled within each stratum, restricted to the number of days with at least one angler-trip estimated within each day;

$=$
y_{khi} = mean proportion of angler-trips for day i that harvest 0 or at least k coho salmon;

$$= \frac{p_{hi}^* \quad \bar{} \\ \sum_{j=1} y_{khij}}{p_{hi}^*} \text{ ; and} \qquad \text{(A5.4)}$$

$\bar{}$
y_{khij} = mean sample proportion of angler-trips for each sample that harvest 0 or at least k fish;

$$= \frac{\sum_{j=1}^{m_{hi}} y_{khijo}}{m_{hi}} . \qquad \text{(A5.5)}$$

-continued-

The variance of the estimated proportion was obtained by the usual three-stage equation:

$$\hat{V}[\bar{y}_{kh}] = \left[(1 - f_{1h}) \frac{s^2_{1kh}}{d^*_h} \right] + \left[\frac{f_{1h}}{d^{*2}_h} \sum_{i=1}^{d^*_h} \left[(1 - f_{2hi}) \frac{s^2_{2khi}}{p^*_{hi}} \right] \right] + \left[\frac{f_{1h}}{d^{*2}_h} \sum_{i=1}^{d^*_h} \frac{f_{2hi}}{p^{*2}_{hi}} \sum_{j=1}^{p^*_{hi}} (1 - f_{3hij}) \frac{s^2_{3khij}}{m_{hij}} \right]; \quad (A5.6)$$

where:

$$s^2_{1kh} = \frac{\sum_{i=1}^{d^*_h} (y_{khi} - \bar{y}_{kh})^2}{d^*_h - 1}; \quad (A5.7)$$

$$s^2_{2khi} = \frac{\sum_{j=1}^{p^*_{hi}} (y_{khij} - \bar{y}_{khi})^2}{p^*_{hi} - 1}; \quad (A5.8)$$

$$s^2_{3khij} = \frac{\sum_{o=1}^{m_{hij}} (y_{khijo} - \bar{y}_{khij})^2}{m_{hij} - 1}; \text{ and} \quad (A5.9)$$

all other terms were as defined in equations 1-10 from Bartlett and Bingham (1991).

Once the estimated proportion and its variances were calculated for all strata in an iteration, the statistics were combined as weighted averages to estimate one set of statistics (p_k's) of harvest distribution for the entire fishery for each type of angler-trip (1-day, 2-day, 3-day, etc.):

$\hat{p}_k$ = the estimated fraction of completed angler-trips in which anglers harvest 0 or at least k coho salmon;

$$= \sum_{h=1}^{s} \hat{W}_h \bar{y}_{kh}; \quad (A5.10)$$

-continued-

$\hat{\hat{V}}[\hat{p}_k]$ = variance estimate, obtained by treating the stratum weights as constants, rather than as estimates, and as such obtained approximately by (see Kish 1965, equations 2.8.5 and 2.8.7, pages 60 and 61);

$$\approx \sum_{h=1}^{s} \hat{W}_h^2 \, \hat{\hat{V}}[\bar{y}_{kh}] \; ; \qquad \text{(A5.11)}$$

where:

$\hat{W}_h$ = estimated relative stratum (equivalent to the ratio of the estimated number of angler-trips for each stratum compared to the total number of angler-trips for the fishery, for each type of angler-trip);

$$= \frac{\hat{A}_h}{\hat{A}} \; ; \qquad \text{(A5.12)}$$

$\hat{A}_h$ = estimated number of angler-trips for each stratum;

$$= D_h \, \bar{\hat{M}}_h \; ; \qquad \text{(A5.13)}$$

$\bar{\hat{M}}_h$ = unrestricted mean estimated number of angler-trips for each stratum;

$$= \frac{\sum_{i=1}^{d_h} \hat{M}_{hi}}{d_h} \; ; \qquad \text{(A5.14)}$$

$\hat{M}_{hi}$ = unrestricted estimated number of angler-trips for each sampled day;

$$= P_{hi} \, \bar{M}_{hi} \; ; \qquad \text{(A5.15)}$$

-continued-

$\bar{M}_{hi}$ = unrestricted mean estimated number of angler-trips for each sampled day;

$$= \frac{\sum_{j=1}^{phi} M_{hij}}{p_{hi}} ; \qquad \text{(A5.16)}$$

$\hat{A}$ equals the total number of estimated angler-trips across all strata; and all other terms are as defined above.

Standard errors were obtained by taking the square root of the variance estimates.

The setting of k_{max} occurred post-season, due to the variety of bag and possession limits that were set for this fishery (e.g., three fish per day prior to 22 July; one fish per day through 5 August; three per day after 5 August to 13 August when escapement goal of 7,500 nonhatchery fish was reached; then the department, by emergency order, liberalized the bag and possession limit to five fish for the remainder of the season in the section of the fishery downstream of the weir).

APPENDIX B

Appendix B1. Information summary collected daily at the Little Susitna River coho salmon weir (rkm 52), 1991.

1. The number of coho salmon passing upstream of the weir (the number of coho salmon observed to pass back over the weir after release are to be subtracted from the daily count of adult salmon passing through the weir and continuing upstream);
2. the number of coho salmon which pass over the weir during boat passage;
3. the number of coho salmon examined for a missing adipose fin;
4. the number of coho salmon observed to have a missing adipose fin;
5. the number of coho salmon sampled for age and sex composition at the weir;
6. the noon (approximate) water temperature at the weir;
7. the number of watercraft passing the weir;
8. the noon staff gauge reading at the weir; and,
9. any other pertinent factors that may affect the efficiency of the weir to accurately census the passing of coho salmon upstream of rkm 52.

Appendix B2. Information recorded by the conducting biologist during the Little Susitna River coho salmon aerial escapement survey, 1991.

1. The number of live coho salmon observed present on spawning index areas between rkm 99 and rkm 163;
2. the number of dead coho salmon observed present on spawning index areas between rkm 99 and rkm 168;
3. the relative water conditions (turbid, clear, high, normal, low) and visibility conditions (poor, good, excellent) during the flight that would aid in subjectively assessing the relative accuracy of the number of fish observed; and,
4. any other pertinent factors that would aid in assessing the relative accuracy of the observation.

APPENDIX C

Appendix C. Estimation equations for the age composition in proportions and in numbers for the fish harvested in the coho salmon sport fishery and the escapement through the weir (rkm 52), in the Little Susitna River, 1991.

Proportions of each age class of fish harvested in each temporal component of the sport fishery or the escapement through the weir, were calculated according to the following procedures:

$\hat{p}_{ut}$ = estimated proportion of the sampled coho salmon harvested that are age *u* within each temporal component;

$$= \frac{n_{ut}}{n_t}; \qquad \text{(C1.1)}$$

where: n_{ut} equaled the number of the sampled coho salmon harvested within each temporal component that are age *u*; and n_t equaled the total number of coho salmon sampled within each temporal component.

The variance of the estimated proportion of coho salmon harvested was estimated approximately by the standard equation for the variance of a binomial proportion (Cochran 1977, equation 3.8, page 52):

$$\hat{V}[\hat{p}_{ut}] \approx \left(1 - \frac{n_t}{\hat{H}_t}\right) \frac{\hat{p}_{ut}(1 - \hat{p}_{ut})}{n_t - 1} \text{ or } \left(1 - \frac{n_t}{N_t}\right) \frac{\hat{p}_{ut}(1 - \hat{p}_{ut})}{n_t - 1}. \qquad \text{(C1.2)}$$

where: $\hat{H}_t$ equaled the estimated harvest of coho salmon in each temporal component, obtained from equation 6 of Bartlett and Bingham (1991); and N_t equaled the number of coho salmon counted past the weir during each weir temporal component period.

Next we estimated weighted proportions for each age class across all temporal components:

$$\hat{p}_u = \sum_{h=1}^{s} \hat{W}_t \hat{p}_{ut} \quad \text{or} \quad \sum_{h=1}^{s} W_t \hat{p}_{ut}; \qquad \text{(C1.3)}$$

where:

$$\hat{W}_t = \frac{\hat{H}_t}{\hat{H}} \quad \text{or} \quad W_t = \frac{N_t}{N}; \text{ and} \qquad \text{(C1.4)}$$

$\hat{H}$ equaled the total harvest or N equaled the total number of coho salmon counted past the weir over all temporal components.

-continued-

The variance of the estimated proportion of fish harvested which are age class *u* across all temporal components, was obtained by Goodman's (1960) equation for the variance of the product of two random variates:

$$\hat{V}[\hat{p}_u] = \sum_{t=1}^{s} \left[\hat{W}_t^2 \hat{V}[\hat{p}_{ut}] + \hat{p}_{ut}^2 \hat{V}[\hat{W}_t] - \hat{V}[\hat{p}_{ut}] \hat{V}[\hat{W}_t] \right] ; \qquad (C1.5)$$

where:

$$\hat{V}[\hat{W}_h] = \left[\frac{\hat{H}_t}{\hat{H}} \right]^2 \left[\frac{\hat{V}[\hat{H}_t]}{\hat{H}_t^2} + \frac{\hat{V}[\hat{H}]}{\hat{H}^2} - \frac{2\,\hat{V}[\hat{H}_t]}{\hat{H}_t\,\hat{H}} \right] . \qquad (C1.6)$$

The variance of the estimated proportion of fish past the weir which are age class *u* across all temporal components, was obtained by:

$$\hat{V}[\hat{p}_u] = \sum_{t=1}^{s} \left[W_t^2 \hat{V}[\hat{p}_{ut}] \right] . \qquad (C1.7)$$

APPENDIX D

Appendix D1. Little Susitna River drainage coho salmon fry release summary from 1982-1990.

Release Location	Date	Size(g)	Total Number	Number Tagged	Tag Code
Little Susitna River	6/22/82	0.4	2,950		
Nancy Lake	6/15/83	0.5	23,652	1,880	B4-07-13
	6/16/83	0.5	80,124	4,605	B4-07-13
	6/17/83	0.6	79,251	2,622	B4-07-13
	6/22/83	0.7	67,815	5,278	B4-07-13
	6/23/83	0.7	15,666	6,450	B4-07-13
	Total		266,508	20,835	B4-07-13
Nancy Lake	6/14/84	1.0	171,194	4,026	B4-14-11
	6/15/84	0.9	164,280	5,174	B4-14-11
	6/19/84	0.9	90,742	631	B4-14-11
	Total		436,047	9,831	B4-14-11
Nancy Lake	6/18/85	0.3	127,000	10,000	B4-15-08
	5/31/85	0.3	164,600		
Horseshoe Lake	6/20/85	0.3	140,000		
	6/21/85	0.3	79,000		
	6/05/85	0.3	229,600		
	6/03/85	0.3	85,000		
Crooked Lake	6/12/85	0.3	68,000		
	6/21/85	0.3	164,000		
Butterfly Lake	6/25/85	0.3	119,000		
Delyndia Lake	6/25/85	0.3	49,000		
	Total	Nancy L.	291,600	10,000	B4-15-08
		All Others	933,600		
Nancy Lake	6/26/86	1.0	211,255	10,300	B3-11-15
	6/27/86	1.0	105,015		
	Total	Nancy L.	316,270	10,300	B3-11-15

-continued-

Appendix D1. (Page 2 of 2).

Release Location	Date	Size(g)	Total Number	Number Tagged	Tag Code
Horseshoe Lake	5/11/88	16.4	15,725		
Horseshoe Lake	6/23/88	0.7	450,000		
Crooked Lake	7/01/88	1.0	105,000		
	7/05/88	1.3	151,000		
Nancy Lake	7/05/88	1.3	174,126	3,126	B3-02-02
	7/07/88	0.7 - 1.3	1,708,939	8,939	B3-02-02
East Papoose L	7/06/88	1.0	172,000		
West Papoose L	7/06/88	1.0	164,000		
Butterfly Lake	7/06/88	1.0	141,000		
Delyndia Lake	7/06/88	1.0	141,000		
Hock Lake	7/06/88	1.0	72,000		
Yohn Lake	7/06/88	1.0	46,000		
My Lake	7/06/88	1.0	58,000		
		Nancy L.	1,883,065	12,065	B3-02-02
		All Others	1,500,000		
	1988 Total		3,383,065		
Horseshoe Lake	7/28/89	1.4	8,400		
Horseshoe Lake	6/19/90	1.0	344,000		
Crooked Lake	6/20/90	1.0	78,000		
Nancy Lake	6/28/90	1.1	155,619	11,619	B3-11-45
	7/06/90	1.5	65,305	28,305	B3-11-45
	7/13/90	1.7	28,722	10,722	B3-11-46
	7/23/90	2.0	223,681	21,681	B3-11-46
My Lake	6/29/90	1.1	23,000		
Yohn Lake	6/29/90	1.1	26,000		
Butterfly Lake	6/29/90	1.1	90,000		
Hock Lake	6/29/90	1.1	40,000		
Delyndia Lake	6/29/90	1.1	89,000		
		Nancy L.	220,924	39,924	B3-11-45
			252,403	32,403	B3-11-46
		All Others	942,403		
	1990 Total		1,415,730		

Appendix D2. Summary of coho salmon smolt stocked in the Little Susitna River from eggs taken at Nancy Lake and incubated at Fort Richardson Hatchery from 1983-1992.

Brood Year	Number Of Eggs Incubated	Release						Dominant Return Year
		Site	Year	Size(g)	Number	Number Marked	Tag Code	
1983	56,000	Nancy Lake	1985	17.1	54,394	12,151		1986
1984	594,000	Nancy Lake	1986	17.2	580,065	24,401	31-17-30	1987
1985	552,000	Houston	1987	19.0	98,156	7,950	31-17-45	1988
		Nancy Lake		19.2	203,011	16,700	31-17-45	
1986	495,400	Nancy Lake	1988	20.1	446,016	24,628	31-17-61	1989
1987	537,877	Houston	1989	18.5	49,349	3,581	31-18-32	1990
		Nancy Lake		20.8	305,548	22,050	31-18-32	
1988	462,000	Houston	1990	20.8	106,242	15,679	31-19-17	1991
		Nancy Lake		20.8	202,114	29,541	31-16-01	
					308,356	45,220		
1989	530,315	Houston	1991	23.4	88,675	16,151	31-19-36	1992
		Nancy Lake		22.9	189,087	30,207	31-19-35	
					277,762	46,358		
1990	590,015		1992					1993

Appendix D3. Estimation equations for the hatchery contribution of stocked coho salmon to the coho salmon sport fishery and to the escapement through the weir (rkm 52) of the Little Susitna River, 1991.

The first step involved estimating the contribution to each sampling stratum (or combined strata as noted above) in the fishery of each particular tag code (using equation [10] from Clark and Bernard 1987):

$\hat{H}_{Ah}$ = estimated contribution of stocked fish from release associated with unique tag code *A* for fishery stratum *h*;

$$= \left[\frac{\hat{H}_h}{n_{2h}} \right] \left[\frac{a_{1h}}{a_{2h}} \right] \left[\frac{m_{1h}}{m_{2h}} \right] \left[\frac{m_{ah}}{\theta_A} \right] ; \qquad \text{(D3.1)}$$

where: $\hat{H}_h$ equals the estimated harvest of all coho salmon within each stratum; n_{2h} is the number of coho salmon inspected for missing adipose fins from the sampled harvest in each fishery stratum; a_{1h} equals the number of coho salmon with a missing adipose fin which were counted and marked with a head strap from each stratum; a_{2h} equals the number of coho salmon heads previously marked with a head strap which arrived at the tag lab, from fish originally sampled from stratum *h*; m_{1h} equals the number of coded wire tags which were detected in the coho salmon heads at the tag lab, from those sampled from stratum *h*; m_{2h} is the number of coded wire tags which were removed from the coho salmon heads and decoded, from coho salmon sampled from stratum *h*; m_{ah} is the number of coded wire tags dissected out of the coho salmon heads and decoded as the unique tag code *a*, originally sampled from stratum *h*; and θ_A equals the proportion of a particular hatchery release which contains a coded wire tag of the unique tag code *A*.

The variance of the above estimate was obtained following the approach proposed by Conrad and Larson (1987), in which the number of tags decoded as a unique tag code (*A*) and the total harvest estimate were treated as random variates, and all other terms in equation D3.1 were treated as constants (accordingly the approach first proposed by Goodman 1960 was used for the second major term in equation D3.2):

$$S^2_{\hat{H}_{Ah}} \approx \left[\frac{1}{n_{2h}} \frac{a_{1h}}{a_{2h}} \frac{m_{1h}}{m_{2h}} \frac{1}{\theta_A} \right]^2$$

$$\left[\hat{H}_h \, V[m_{A_h}] + m^2_{A_h} \, \hat{V}[\hat{H}_h] - V[m_{A_h}] \, \hat{V}[\hat{H}_h] \right] ; \qquad \text{(D3.2)}$$

-continued-

where: $\hat{V}[\hat{H}_h]$ equals the estimated variance of overall coho salmon harvest estimate for stratum h, obtained from creel survey sampling programs; and

$V[m_{A_h}]$ = variance of "random variate" m_{A_h}, approximated by the approach used by Clark and Bernard (1987; equation [12]);

$$\approx \frac{n_{2_h}(n_{2_h}-1)a_{2_h}(a_{2_h}-1)m_{2_h}(m_{2_h}-1)\hat{H}_{a_h}(\hat{H}_{a_h}-1)\theta_A^2}{\hat{H}_h(\hat{H}_h-1)a_{1_h}(a_{1_h}-1)m_{1_h}(m_{1_h}-1)}$$

$$+ \frac{n_{2_h}a_{2_h}m_{2_h}\hat{H}_{A_h}\theta_A}{\hat{H}_h a_{1_h} m_{1_h}}$$

$$- \left\{ \frac{n_{2_h}a_{2_h}m_{2_h}\hat{H}_{A_h}\theta_A}{\hat{H}_h a_{1_h} m_{1_h}} \right\}^2 . \qquad \text{(D3.3)}$$

The final step in calculating the variance of the contribution estimate for each tag code was to perform the following bias correction (Clark and Bernard 1987; equation [15]):

$$\hat{V}[\hat{H}_{A_h}] = \left\{ \frac{(\hat{H}_h-1)n_{2_h}(a_{1_h}-1)a_{2_h}(m_{1_h}-1)m_{2_h}}{\hat{H}_h(n_{2_h}-1)a_{1_h}(a_{2_h}-1)m_{1_h}(m_{2_h}-1)} \right\} S^2_{H_{A_h}} . \qquad \text{(D3.4)}$$

In order to obtain the estimated contribution to the fishery across combinations of different tag codes and/or different strata, the following equations were used (as outlined by Clark and Bernard 1987, equation [16]):

$\hat{H}_C$ = estimated total contribution of a combination of tag codes and sampling strata;

$$= \sum_{h=1}^{s} \sum_{A=1}^{t} \hat{H}_{A_h} \qquad \text{(D3.5)}$$

where: s equals the number of strata to be combined; and t is the number of tag codes to be combined.

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The variance of this combined estimate was obtained by (Clark and Bernard 1987, equation [17]):

$$\hat{V}[\hat{H}_C] = \left[\sum_{h=1}^{s} \sum_{A=1}^{t} \hat{V}[\hat{H}_{Ah}] \right] + \left[2 \sum_{h=1}^{s} \sum_{A=1}^{t} \sum_{B>A}^{t} \hat{cov}[\hat{H}_{Ah}, \hat{H}_{Bh}] \right]; \qquad (D3.6)$$

where:

$\hat{cov}[\hat{H}_{Ah}, \hat{H}_{Bh}]$=estimated covariance between the estimated contributions for unique tag code *A* and *B* within stratum *h* (note that we assume that sampling was conducted independently between strata, therefore covariances are only needed for the within stratum values), obtained as outlined by Clark and Bernard (1987, equation [22]);

$$= \hat{H}_{Ah}\,\hat{H}_{Bh} \left[\frac{\hat{H}_h(n_{2_h}-1)a_{1_h}(a_{2_h}-1)m_{1_h}(m_{2_h}-1)}{(\hat{H}_h-1)n_{2_h}(a_{1_h}-1)a_{2_h}(m_{1_h}-1)m_{2_h}} - 1 \right]. \qquad (D3.7)$$

Note, that for the hatchery contribution to the escapement past the weir, the same equations were used above, except we set the variance of each stratum "estimate" to zero since the weir counts were obtained without sampling error. Additionally, note that in applying the above equations to the escapement survey at the weir, we assumed that $m_1 = m_2 = a_1 = a_2 = m_A$ for all strata, since all we observed in this sampling program is the number of adipose finclipped coho salmon (i.e., no heads collected from the weir samples). Finally, note that the estimated harvest in the equations above was replaced by the known escapement count.

APPENDIX E

Appendix E. Daily and cumulative counts by salmon species through the Little Susitna River weir, 25 July through 16 September 1991.

	Chinook Salmon		Sockeye Salmon		Chum Salmon		Coho Salmon		Pink Salmon	
Date	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
25-Jul[a]	2	2	18	18	20	20	0	0	0	0
26-Jul	2	4	386	404	56	76	23	23	5	5
27-Jul	1	5	682	1,086	353	429	192	215	9	14
28-Jul	1	6	686	1,772	390	819	199	414	6	20
29-Jul	2	8	134	1,906	166	985	20	434	1	21
30-Jul	6	14	200	2,106	159	1,144	191	625	1	22
31-Jul	5	19	232	2,338	263	1,407	73	698	0	22
01-Aug	4	23	528	2,866	185	1,592	15	713	1	23
02-Aug	3	26	1,675	4,541	506	2,098	166	879	1	24
03-Aug	6	32	600	5,141	857	2,955	93	972	4	28
04-Aug	2	34	1,209	6,350	540	3,495	144	1,116	13	41
05-Aug	0	34	648	6,998	620	4,115	648	1,764	5	46
06-Aug	0	34	333	7,331	671	4,786	390	2,154	0	46
07-Aug	0	34	686	8,017	818	5,604	360	2,514	4	50
08-Aug	2	36	461	8,478	682	6,286	455	2,969	5	55
09-Aug	0	36	235	8,713	393	6,679	1,223	4,192	7	62
10-Aug	2	38	166	8,879	448	7,127	792	4,984	2	64
11-Aug	0	38	137	9,016	257	7,384	1,428	6,412	7	71
12-Aug	0	38	110	9,126	115	7,499	1,828	8,240	11	82
13-Aug	0	38	33	9,159	144	7,643	609	8,849	1	83
14-Aug	0	38	36	9,195	169	7,812	2,911	11,760	10	93
15-Aug	0	38	21	9,216	147	7,959	1,482	13,242	3	96
16-Aug	0	38	16	9,232	148	8,107	2,053	15,295	3	99
17-Aug	0	38	56	9,288	224	8,331	6,819	22,114	10	109
18-Aug	0	38	16	9,304	68	8,399	4,001	26,115	1	110
19-Aug	0	38	21	9,325	61	8,460	2,068	28,183	2	112
20-Aug	0	38	4	9,329	125	8,585	207	28,390	1	113
21-Aug	0	38	9	9,338	166	8,751	413	28,803	0	113
22-Aug	0	38	5	9,343	157	8,908	411	29,214	1	114
23-Aug	0	38	5	9,348	137	9,045	360	29,574	0	114
24-Aug	0	38	2	9,350	94	9,139	212	29,786	0	114
25-Aug	0	38	1	9,351	95	9,234	391	30,177	0	114
26-Aug	0	38	2	9,353	72	9,306	583	30,760	2	116
27-Aug	0	38	2	9,355	65	9,371	254	31,014	1	117
28-Aug	0	38	2	9,357	65	9,436	39	31,053	0	117
29-Aug	0	38	1	9,358	53	9,489	49	31,102	0	117
30-Aug	0	38	7	9,365	60	9,549	103	31,205	0	117
31-Aug	0	38	2	9,367	59	9,608	692	31,897	0	117

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Appendix E. (Page 2 of 2).

	Chinook Salmon		Sockeye Salmon		Chum Salmon		Coho Salmon		Pink Salmon	
Date	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
01-Sep	0	38	3	9,370	42	9,650	988	32,885	0	117
02-Sep	0	38	1	9,371	41	9,691	756	33,641	0	117
03-Sep	0	38	1	9,372	44	9,735	902	34,543	0	117
04-Sep	0	38	1	9,373	15	9,750	78	34,621	0	117
05-Sep	0	38	2	9,375	44	9,794	952	35,573	0	117
06-Sep	0	38	0	9,375	29	9,823	361	35,934	0	117
07-Sep	0	38	0	9,375	5	9,828	607	36,541	0	117
08-Sep	1	39	0	9,375	12	9,840	1,203	37,744	0	117
09-Sep	0	39	0	9,375	7	9,847	370	38,114	1	118
10-Sep	0	39	0	9,375	15	9,862	397	38,511	0	118
11-Sep	0	39	0	9,375	8	9,870	389	38,900	1	119
12-Sep	0	39	2	9,377	8	9,878	212	39,112	0	119
13-Sep	0	39	0	9,377	0	9,878	47	39,159	0	119
14-Sep	0	39	0	9,377	8	9,886	47	39,206	0	119
15-Sep	0	39	0	9,377	4	9,890	19	39,225	0	119
16-Sep[b]	0	39	0	9,377	7	9,897	16	39,241	0	119

[a] Weir in place and fish tight on 25 July 1991.

[b] Weir removed on 17 September 1991.

APPENDIX F

Appendix F. Computer data files and analysis programs developed for the coho salmon creel survey and escapement studies on the Little Susitna River, 1991.

Data Files

K004BSA1.DTA	Burma Road angler interview data file for all anglers;
K004BSD1.DTA	Burma Road angler interview data file for anglers fishing downstream of the ADF&G weir;
K004BSU1.DTA	Burma Road angler interview data file for anglers fishing upstream of the ADF&G weir;
K004BCA1.DTA	Burma Road angler count data file for all anglers;
K004BCD1.DTA	Burma Road angler count data file for anglers fishing downstream of the ADF&G weir;
K004BCU1.DTA	Burma Road angler count data file for anglers fishing upstream of the ADF&G weir;
K004RS_1.DTA	Miller's Reach boat launch angler interview data file;
K004RC_1.DTA	Miller's Reach boat launch angler count data file;
K004LS_1.DTA	Miller's Landing boat launch angler interview data file;
K004LC_1.DTA	Miller's Landing boat launch angler count data file;
K004DBA1.DTA	Weir site biological data file;
K004BBA1.DTA	Creel survey at Burma Road boat launch biological data file;
K004UBA1.DTA	Creel survey at Miller's Reach and Landing boat launch biological data file.

Analysis Programs

LSU.EXE	Research and Technical Services (RTS) program for preprocessing Burma road boat launch mark-sense angler interview data files;
UCSP91.EXE	RTS program to analyze raw data files from direct-expansion and roving creel surveys and generate estimates of angler effort, catch, and harvest;
DRA31LSU.RD	RTS report descriptive file for stage 1 of a stratified-random, three-stage, direct-expansion creel survey;
DRA32LSU.RD	RTS report descriptive file for stage 2 of a stratified-random, three-stage, direct-expansion creel survey;
DRA33LSU.RD	RTS report descriptive file for stage 3 of a stratified-random, three-stage, direct-expansion creel survey;
SFXTAB.EXE	RTS program used to cross-tabulate biological data files and produce either "discrete" or "continuous" tables of age, sex, length, and weight data;
MENU91.BAT	Series of RTS programs used to generate listing, frequency, and litho code reports from raw data;
LSU91CPU.SAS	SAS® System program used to estimate CPUE as index of abundance;
LSU91CHD.SAS	SAS® System program used to estimate distribution of angler catch and harvest;
AGESS91.WK1	Lotus 1-2-3® worksheet used to weight and apportion coho salmon harvest estimates by sex and age, within and across all temporal components;
AGESSW91.WK1	Lotus 1-2-3® worksheet used to weight and apportion coho salmon weir escapement estimates by sex and age, within and across all temporal components.

Data files are archived with the Alaska Department of Fish and Game, Division of Sport Fish, Research and Technical Services Unit, 333 Raspberry Road, Anchorage, Alaska 99518-1599. Contact Gail Heineman or Donna Buchholz (267-2369) for copies of the files and descriptions of the file format.